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THE STREAM OF LIFE.

(*Concluded from page* 3.)

IN the carboniferous strata, which in some places attain a thickness of nearly four miles, we find evidence of an amazing wealth of vegetation—uniform in general character, for as yet the earth seems to have had no seasons so far as heat was concerned—but very varied in details. The most characteristic peculiarity of animal life was the prevalence of amphibia, represented chiefly by immense creatures resembling the modern salamander, but attaining a length of seven or eight feet. Enormous sharks swept through the seas of the time, armed with teeth capable of crushing the strong incasing armour of the ganoid fishes which probably formed their prey. As the Permian era came on, the Flora and Fauna changed by slow processes of development, both still retaining, however (over the whole earth, so far as can be judged), their tropical character.

We find so marked a contrast in passing from the Permian system to the Triassic—that is, from the highest of the primary to the lowest of the secondary strata—that had not experience taught us to recognise in such marked change merely evidence that many leaves are missing from the geological record, we might be tempted to believe, with the geologists of former times, that the primary forms of life had been for the most part replaced by new creatures. In our time, however, all we infer from the great change in many forms of animal and vegetable life is that immense periods of time passed after the last of the Permian strata were deposited before the first of the Triassic rocks began to be formed. The records of these vast time intervals have been destroyed by denudation.

Some, however, of the old genera of plant life and of animal life still remained. Conifers, which had existed in the previous era, were now more numerous and in greater variety. But Cycads were the predominating form of vegetable life throughout the Mesozoic period, which has been called, on this account, the "Age of Cycads." Amphibians now increased in numbers, while lizards made their first appearance (so far, at least, as the geological record attests). Deinosaurs, which may be regarded as a connecting link between birds and reptiles, appeared and disappeared during the Mesozoic era—becoming extinct, like other transitional types, within a comparatively short time, though the absolute duration of their existence on the earth may probably be measured by millions of years. The footprints of some of these creatures, which walked on their hind legs, were mistaken by the earlier geologists for the traces of gigantic birds; but although birds, and gigantic ones, appeared during the Mesozoic ages, the deinosaurs were not flying creatures. When we consider the enormous size of some of them, as the *brontosaur*, whose feet left imprints a square yard in area; the *stegosaur*, whose bony back-plates were 3 feet across; and the *atlantosaur*, the most massive of all known creatures, probably of all creatures which have ever existed (it seems to have been about 100 feet long and 30 feet high), we may regard the power of flying as not one which deinosaurs needed or were likely to possess.

In this age, also, the great sea saurians throve, multiplied and died out. The ichthyosaur, with eyes a foot in diameter; the long-necked plesiosaur, the pythonomorphic, or serpentine, saurians, of which no fewer than forty varieties have been recognised, some of them being more than 75 feet in length, were among the denizens of the sea in Mesozoic time.

This was the age also of those bat-winged reptiles, the Pterosaurs, some of which were of enormous size. But these again were probably transitional forms, and are now extinct. The birds of the Mesozoic ages, which show many reptilian characteristics, represent more successful lines of development; and though none of the birds known to belong to Mesozoic times remained in later ages, the birds even of our own time afford in their structure abundant evidence of their descent from those earlier birds, or from their contemporaries.

It was in the long-lasting Mesozoic or secondary ages, further, that mammals, afterwards to obtain dominion over the earth, first made their appearance, though the traces of them are but few and far between. Teeth of a small marsupial animal akin to the banded ant-eater of New South Wales are found as low as the Triassic strata (the lowest of the secondary formations), while in the Jurassic, or next higher system, other forms of insectivorous marsupials are found, along with one which Owen regarded as an herbivorous placental mammal and another which he regarded as probably carnivorous.

Geology has now long passed that stage of its progress when the tertiary, or Cainozoic, periods were supposed to be separated by a distinct line of demarcation from the secondary, or Mesozoic. The cretaceous system, or chalk, was found to be in many places succeeded by beds of pebble, sand and clay, of entirely different character from any of the chalk formations. In these upper beds no fossils could be found which had been recognised in the chalk. But researches, at once wider and more detailed, showed that parts of the leaves which seemed thus to be missing exist elsewhere. The break in the continuity of deposits in some places shows only that denudation had either completely removed the missing strata before the higher beds began to be deposited, or else in certain regions no strata were deposited.

Yet on the whole we find a marked change in the earth's aspect in Cainozoic times, as well as a characteristic difference in the manner in which the crust of the earth behaved. During the Tertiary period the continents of the earth were fashioned nearly into the forms they have in our own time. Processes of contraction affecting a crust which, owing to increased thickness and diminished plasticity, no longer yielded easily to the pressures and strains acting upon it, resulted in the formation of the great mountain ranges, by the upheaval (through side pressures) of the thick and deep strata formed during the primary and secondary periods upon the original crust. Parts of what was sea-bed at the beginning of Tertiary time are now found three miles above the sea level; and doubtless other portions were raised even higher, but have been carried down from the positions so reached, by the action of the denuding forces which have carved the peaks and pinnacles of mountain ranges, until in many parts the inner Archæan core has been exposed.

In the Tertiary strata we recognise first the signs of a diversity of temperature beginning to exist in different parts of the earth. Early in Tertiary time, indeed, even the

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arctic regions had a mild climate, but towards the close of the long-lasting periods of the Tertiary age snow and ice had spread, not only over the whole of the arctic regions, but even over parts of the European and American continents which at present are free from them. This, however, must be regarded as indicating only a temporary extension of the northern snows and ice. Even during eras belonging to the close of Tertiary time the earth possessed on the whole a warmer and more equable climate in high latitudes than she has now.

The vegetation of the earth now began to resemble closely the vegetation of the present day. Nearly all the genera of later Tertiary vegetation still throve on the earth. Animal life began also to resemble the animal life of to-day much more closely than during preceding eras. Mammals not only made their appearance on the earth, but, as usual with successful incoming types, they showed at the outset of their career a richness and fulness of development such as they do not present in these times. The pachyderms, still the largest of the land mammals, were much larger in Tertiary times than now. In Tertiary ages, also, gigantic cetacean sea mammals, the ancestors of the whales, dolphins and kindred races of our own times, gradually took the place of the monstrous sea saurians of preceding ages.

The division of Tertiary time into Eocene, Miocene, and Pliocene periods indicates the recognition among geologists of the growth and development of modern forms of animal and vegetable life during the Cainozoic eras. For these names imply simply "Dawn of Recent," "Fewer Recent," and "More Recent," "forms of life" being understood. The lower Tertiary strata are called Eocene to show that recent forms of life begin to be recognised in those strata; in the Miocene strata recent forms of life are more numerous than they had been but still not so numerous as the ancient forms, while in Pliocene recent forms have not only increased in number but they now exceed the ancient forms, and in gradually increasing degree, till as we are passing from the upper Tertiary to the lower Quaternary or recent strata we have to change our descriptive term from Pliocene or more recent (than ancient) to Pleistocene, or mostly recent.

In considering the Flora of the Eocene period, we are chiefly struck by the evidence it affords of the extension of a climate still tropical over regions now temperate, and of a climate still warm over regions now intensely cold. Plants now only found in the hotter parts of Asia, Africa, America, and Australia throve then in Canada, Scandinavia, and Siberia. Ferns and evergreens were numerous, but many deciduous trees—elms, hazels, willows, planes, chestnuts, &c., —had now made their appearance. The Fauna of this period also indicates a generally tropical climate extending over the temperate zones, and a temperate climate extending to far within the arctic regions. Reptilian life was no longer so preponderant as during Mesozoic time, the reptiles still thriving in the Eocene period being chiefly turtles, tortoises, and crocodiles, closely resembling those now existing. Remains of birds are found more freely in Eocene strata than in the lower formations, though avian fossils are naturally not abundant in any strata, the power of flight saving birds from most of those forms of death which favoured the preservation of fossil remains. True mammals now made their appearance in great numbers. Small pony-like animals appeared—the ancestors probably of the horse, ass, zebra, and quagga, but differing from the modern equine races in possessing most of the toe of each foot, whereas the Equus of to-day possesses only the middle toe complete, the side toes being represented only by rudimentary splints. Hogs of various kinds, deer and antelopes, squirrels, lemurs and bats had now appeared. Races also now seen for the first time, but not destined to last to our own day, throve and multiplied during the Eocene period—creatures (the tinoceras and deinoceras) like the rhinoceros in structure, but having six horns instead of two, and like the elephant in size, were now the most powerful denizens of the forest.

Throughout the closing part of the Eocene period, called sometimes the "Oligocene" (or "Few-recent"), there was a general though slow progress towards the condition found during Miocene time, during which the Flora and Fauna showed a marked advance towards the characteristic forms of recent geological time. Still, however, even in the Miocene age, the forests which adorned temperate regions resembled rather those found in India and Brazil than the forests of middle Europe and other such regions now. Beeches, laurels, oaks, and poplars, as well as magnolias, myrtles, sumachs, mimosas, and acacias, were now abundant. Through the forests ranged giraffes, deer, antelopes, three-toed horses, wildcats, bears, sabre-toothed lions, monkeys, and apes. The deinotherium and mastodon were doubtless, however, the most powerful land animals; the deinotherium, as large as the elephant, with two immense tusks in the lower jaw, curved somewhat like those of the walrus; the mastodon, a form of elephant, but in some cases armed with four tusks, two in the lower as well as two large tusks in the upper jaw. The forms of insect life also were particularly rich, especially the wood beetles, which attained often singularly large dimensions. Frogs, toads, lizards, and snakes were also numerous in the Miocene period. Large cetaceans traversed the Miocene seas (their ear-bones are found in considerable numbers in the raised sea-beaches belonging to this part of Tertiary time).

In Pliocene times, as the name implies, modern forms of vegetable and animal life had become still more common. Tropical types of vegetation were no longer found in the higher temperate latitudes, and the forms gradually approximated more and more in character to those now occupying the corresponding regions. The Fauna also presented similar characteristics. Tribes of animals roamed over Europe in the earlier portions of the Pliocene period which are now found only on the southern side of the Mediterranean. In England, even in the latter part of Pliocene time, the hyena, rhinoceros, elephant, and other animals, now limited to tropical or sub-tropical regions, must have been numerous to account for the frequency of their remains.

No definite dividing line can be drawn between the Tertiary and Quaternary periods. The change from Eocene to Miocene, or from Miocene to Pliocene, corresponded closely in character with the change from Pliocene to Pleistocene. Ever since the time when life, vegetable or animal, had first appeared on the earth, multitudinous forms of life had come into existence, had risen into greater or less prominence according to their surroundings, and had in some cases died out, in others had developed succeeding races more or less closely akin to them, and in yet others had continued scarcely changed even throughout the millions of years which separate the beginnings of the Palæozoic periods from our own time.

The steady advance of the stream of life, with its various waves thus either dying out, or merging into other waves, or progressing scarcely changed age after age, had gradually led to the development of more and more of those forms of vegetable and animal life which we regard as belonging specially to the present age of our earth's history. For gradually the earth's surface had changed from a condition utterly unlike what now exists to nearer and nearer resemblance to its present aspect. At the beginning the internal heat had extended its influence over the whole surface of the earth, throughout the whole ocean,

even throughout the whole atmosphere; and the stream of life on the earth had corresponded in character to this uniformity of thermal condition. But as during millions of ages the internal heat gradually diminished, the earth began to recognise, as it were, more clearly age after age the influence of the central sun, one day to become supreme in determining the conditions of life. Throughout the later Palæozoic, the earlier and later Mesozoic, and even the earlier Cainozoic periods, the sun's influence was small in determining differences of condition between different parts of the earth. But from the middle of the Tertiary era onward to the beginning of the era which we recognise as recent—though in reality it has already lasted some 200,000 or 300,000 years—the influence of the sun has in this sense been paramount, that it has divided the earth into climates, corresponding generally though not exactly with zones limited by various latitudes; that is, with zones within which the sun's direct influence as measured by his midday height in different parts of the year has such and such definite range.

What we call the Quaternary period may be regarded as beginning with the time when the sun's influence thus became predominant; when the earth's surface became divided in respect to the forms of vegetable and animal life, as well as in the astronomical sense, into the tropical and sub-tropical zones, the temperate zones, and the arctic and antarctic regions. The range of the various climates which we may call tropical, temperate, and arctic, altered measurably, even markedly, from time to time. Sometimes the glacial regions invaded regions which had been temperate in climate, nay, had even presented semi-tropical forms of life; at others the ice masses retreated even within their present limits.

MOON LORE AND ECLIPSE SUPERSTITIONS.

BY "STELLA OCCIDENS."

IN the beginning, according to the Elder Edda, there were two worlds—Niflheim, or the nebulous world, and Muspelheim, or the fire-world. Muspelheim was so hot that it burned and blazed. The heavenly bodies were made from its sparks, and these were placed in the heavens by the gods, to give light to the world.

The sun knew not his proper sphere,
The stars knew not their proper place,
The moon knew not where her position was;
There was nowhere grass until Bor's sons
The expanse did raise, by whom the great Midgard was made.
From the south the sun shone on the walls;
Then did the earth green herbs produce.
The moon went ahead, the sun followed,
His right hand held the steeds of heaven.

Mundilfare was the father of the sun and moon, and they were placed in the heavens. The sun travels at a great rate, as if some one were pursuing her for her destruction. It was supposed that a wolf, called Skol, pursued the sun, and would one day overtake and devour her. In like manner a wolf called Hate—Hrodvitneson—runs before the sun, and pursues the moon, that will one day be caught by him. These two wolves are the sons of a giantess, who dwells in a wood called Jarnved, situated east of Midgard (the earth, and the abode of a race of witches). The most formidable of all these witches is one called Maanagarm (moon-swallower). He is filled with the life-blood of men who draw near to their end, and he will swallow up the moon, and stain the heavens and the earth with their blood:—

The moon's devourer, in form most fiend-like,
And filled with the life-blood of the dead and the dying,
Reddens with ruddy gore the seats of the high gods.
Then shall the sunshine of summer be darkened,
And fickle the weather! Conceive ye this or not?*

A Mongolian myth asserts that the gods determined to punish Arakho for his misdeeds; but he hid so well that no one could find his hiding-place. They therefore asked the sun, who gave an unsatisfactory answer; but when they asked the moon, she told where he was. So Arakho was dragged forth and chastised. In revenge he pursues the sun and moon, and, whenever he comes near enough, an eclipse occurs. To help the sun and moon in their sad plight a tremendous noise is made, till Arakho is scared away.

The Aleutians and the Icelanders apparently have the idea that the moon should be treated with great respect, otherwise she would punish them by throwing down stones. A story is told about an Icelander who stole a piece of cheese. Whilst he was eating it, he happened to notice the moon shining brightly overhead. He stuck a piece on the end of his knife and offered it to the moon. Another time a sheep-stealer, who was feasting on a leg of mutton he had stolen, observed the moon shining bright and clear. He also invited the moon to take part in the feast in the following words:—

O moon, wilt thou
On thy mouth now
This dainty bit of mutton eat?

A voice from the heavens replied:—

Wouldst thou, thief, like
Thy cheek to strike
This fair key, scorching red with heat?

A red-hot key fell from the sky, burning on the thief's cheek a mark which remained for ever afterwards. This was supposed to have originated the custom of branding thieves, though why a key should have been chosen in this case it is difficult to imagine.† In Scotland, Devonshire, and Cornwall, pointing at the moon is an insult to be carefully avoided, or the most dire results may follow.

At Whitby when the moon is surrounded by a halo of watery clouds, the seamen say that there will be a change of weather, for the moon-dogs are about. An amusing story is told about a fisherman in Torquay. A gale having taken place during the night, he said he had foreseen it, as he had noticed a star ahead of the moon towing her, and another astern chasing her—"I know'd 'twas coming safe enough."

In the Vedic hymns Rakha, the full moon, is supposed to make beautiful garments for night and morning, with a needle which can never be broken. She weaves together the roseate hues of morning, and the soft mellow tints of evening. The Danes have elves called "Moon Folk." The man of this race is like an old man with a low-crowned hat upon his head; the woman is very beautiful in front but behind she is hollow, like a dough-trough, and she has a sort of harp on which she plays and lures young men with it, and then kills them. The man is also an evil being, for if any one comes near him he opens his mouth and breathes upon the rash mortal, and his breath causes sickness. It is easy to see what this tradition means; it is the damp marsh wind laden with foul and dangerous odours; and the woman's harp is the wind playing across the marsh-

* "Norse Mythology," Anderson, pp. 176–179.
† Harley, "Moon Lore," p. 150.

rushes at nightfall.* In the "Midsummer Night's Dream" the fairy queen says to the king:—

> These are the forgeries of jealousy;
> And never, since the middle summer's spring,
> Met we on hill, in dale, forest, or mead,
> By pavèd fountain, or by rushy brook,
> Or in the beachèd margent of the sea,
> To dance our ringlets to the whistling wind;
> But with thy brawls thou hast disturbed our sport.
> No night is now with hymn or carol blest:
> Therefore the moon, the governess of floods,
> Pale in her anger, washes all the air,
> That rheumatic diseases do abound;
> And this same progeny of evil comes
> From our debate, from our dissension;
> We are their parents and original.

Among the Mexicans an eclipse of the moon is supposed to be the moon devoured by a dragon. The Hindoos have the same belief, and both nations continued to use the expression long after they had discovered the true cause of an eclipse.† Captain Beechman relates that one evening when he was at supper with some friends in the island of Borneo, they heard a great noise outside. "The natives were yelling, and clattering brass pans and gongs, and firing off guns. When we inquired the reason of their excitement, one of the natives pointed up to the heavens, and said, 'Look there; see, the devil is eating up the moon!'"

Among the Chinese the belief exists that the moon during an eclipse is being devoured by a hungry monster. In order to frighten him away, and to save the moon from total destruction, certain ceremonies are performed by the Chinese mandarins, which form, in fact, part of their official business. An instrument made of bamboo splints is beaten, which makes a great noise, supposed to penetrate the very temple of Heaven itself. Tapers are lighted at the beginning of an eclipse, incense is burned, the mandarins prostrate themselves on the ground, and the priests recite formulas, all this lasting until the eclipse has passed off. We are naïvely told that they are invariably successful in driving away the hungry monster.‡

At one time in Canton the sky happened to be cloudy during an eclipse, and we are told that the courtiers congratulated the emperor that he had been spared the pain of seeing the sun devoured.

Among some of the American Indian tribes a belief exists that the moon is hunted by huge dogs, catching and tearing her till her soft light is reddened and put out by the blood flowing from her wounds.

"At a lunar eclipse the Orinoco Indians would work hard, as they imagined the moon was veiling herself in anger at their habitual laziness." §

It was customary among the Romans to take their brazen pots and pans and beat them together, making a most unearthly noise, during an eclipse. They also lit torches and firebrands, and carried them about with them, hoping by these means to release the moon. The Mexicans would make a great noise during the eclipse with musical instruments, and would make their dogs howl, hoping the moon would have pity on them because of their cries. The Creeks did likewise, and they explained this strange custom by saying that the big dog was swallowing the sun, and they could prevent him from doing so by whipping the little ones.‖

The people of Tahiti were filled with terror during an eclipse, and would go to the temple and pray for the moon's release. They would offer presents to the god whom they supposed to be swallowing the moon.*

The Sinalos fancied that a battle was taking place in the moon, of great consequence to those on earth. The people would encourage the moon by shouting and yelling, and would shoot flights of arrows at her, so as to distract the enemy.†

In eclipses of the moon the Greenlanders carry boxes and kettles to the roofs of their houses, and beat on them as hard as they can. The Lithuanians think a demon is attacking the chariot of the sun; darkness comes, and though the sun will be saved many times, yet it must be destroyed at the end of the world. Among the Moors the people run about as if mad during an eclipse, firing their rifles, so as to frighten the monster, who, they suppose, wishes to devour the orb of day. The women bang copper vessels together, making a noise to be heard at a very great distance.‡

* "Fairy Tales: their Origin and Meaning." By John Thackray Bunce, p. 131.
† Grimm, "Teutonic Mythology," p. 707.
‡ Max Müller, "Chips from a German Workshop," vol. ii. p. 269.
§ Harley, "Moon Lore," p. 161.
‖ Ibid. p. 168.

* Harley, "Moon Lore," p. 173. † Ibid. p. 173.
‡ Grimm's "Teutonic Mythology," p. 707.

TRICKS OF MEMORY.

MEMORY, which differs so greatly among individual men, varies also in such marked degree in the same person at different times that we are all interested in the inquiry how far memory is a measure of mental strength. In childhood and boyhood we find memory occupying so high a position among mental qualities, that the idea grows up with most of us that he who has the best memory has also most talent, if even a remarkable memory be not regarded as of itself proving absolute genius. At least this is so in most of our schools, where the boy who remembers his lessons best takes highest position, not he who best understands them.

I learned very early that memory and mental power, though they may be associated together, are yet very different things. I valued my memory, which had often stood me in good stead in examinations, the only tests with which boyhood is apt to be acquainted; but I valued more the power of understanding and enjoying the reasoning of dear old Euclid, the one geometrician with whom, in those days, English school lads could become acquainted. Soon after I had left school—and when I was a freshman at college—I made the acquaintance of a young man of about my own age who possessed a most marvellous memory, while he also showed most marvellous mental density. He had occasion to pass examinations in Euclid, and one would have said that he would have been singularly successful in these examinations, for though he had only read through our college Euclid once, he could recite or write out the whole of it. Or, if preferred, he could begin at any point where one might start him and reproduce any quantity *verbatim et literatim—atque punctuatim*, so far as that was concerned. But not only was he utterly unable to understand a word of it all—he had not even brains enough to keep his real ignorance of Euclid to himself. He was always forgetting the good old rule *ne quid nimis*; and as he did not know where to stop in his marvellous recitations, the examiners naturally came to the conclusion, perfectly justified by the facts, that though he knew his Euclid by heart he knew nothing about geometry. His knowledge was akin to that of one who should repeat by rote a number of Greek or Hebrew words the meaning of which was unknown to him; or like that of a tutor I once had,

who when hearing me deal with a problem in Euclid would send me back to relearn my lesson if I called a triangle A C B instead of A B C as the book showed it.

We need not then either despair of our mental powers when we hear of marvellous feats of memory, or think that our minds are failing because with advancing years our memory may occasionally play us false. Memory, as Dr. Diordat, of Montpelier, long since pointed out, and as hundreds of facts show, is rather the offspring of the vital force than of the intellectual principle; and it is not surprising if in old age, when the vital force diminishes, memory should sometimes fail, even while the intellectual power preserves its full integrity. As for marvellous feats of memory, though they certainly indicate possibilities of future developments which would greatly increase man's grasp over mental problems, they need no more discourage those who feel incapable of any achievements in this line than the mental powers of Blind Tom should cause those who see his performances to despair because they can never hope to do the like.

The examples themselves which most strikingly display the capacity of special brains for remembering words and syllables show also how little this capacity has to do with intellectual power—some of them indeed seem almost to suggest that a very keen memory may be a mark of disease. That excessive keenness of memory may result from a diseased cerebral action is indeed certain; but fortunately we are not obliged to regard this fact as giving any unpleasant significance to exceptionally good powers of remembrance. If foolish, or even idiotic persons, or persons in the delirium of fever, have manifested remarkable memories, men like Macaulay, Prescott, Euler, and others have had marvellous memories without being feeble-minded and without the aid of disease.

Pepys tells us of an Indian who could repeat a long passage in Greek or Hebrew after it had been recited to him only once, though he was ignorant of either language. This man would doubtless have been able to repeat (so far as his vocal organs would permit him to imitate the sounds) the song of a nightingale or a lark, through all its ever-varying passages, during ten or twenty minutes, and with as much understanding of its significance as of the meaning of the Greek and Latin words he recited so glibly. We certainly need not envy that particular "poor Indian" his "untutored mind," though as certainly the power he possessed would be of immense value to a philosopher.

If any one is disposed to believe that perhaps after all that Indian may have been a man of powerful understanding, a case of even more wonderful recollection of mere sounds will at least dispose of the idea that the man's peculiarly retentive memory proved mental power. Coleridge relates, in his "Literaria Biographia," that in a Roman Catholic town in Germany a young woman who could neither read nor write was seized with a fever, during which, according to the priests, she was possessed by a polyglot devil. For she talked Latin, Greek, and Hebrew, besides uttering sounds which, though not understood by her hearers, had doubtless meaning, but belonged to languages unknown to them. "Whole sheets of her ravings were written out," says Coleridge, "and were found to consist of sentences intelligible in themselves, but having slight connection with each other." It appeared rather inconsistent with the theory of demoniac possession that some of these sentences were Biblical; but as it is proverbial that the devil can quote Scripture for his purpose, this evidence might not have availed to save the girl from such rough treatment for her "possession" as would probably have served very ill for her fever. Fortunately, a physician, who, being sceptically inclined, was disposed to question the theory of a polyglot spirit, "determined to trace back the girl's history. After much trouble he discovered that at the age of nine she had been charitably taken by an old Protestant pastor, a great Hebrew scholar, in whose house she lived till his death. On further inquiry it appeared to be the old man's custom for years to walk up and down a passage of his house into which the kitchen opened, and to read to himself in a loud voice out of his books. The books were ransacked, and among them were found several of the Greek and Latin fathers, together with a collection of Rabbinical writings. In these works so many of the passages taken down at the young woman's bedside were identified, that there could be no reasonable doubt as to their source."

If the girl had remembered these passages in a normal way, and had merely uttered them during her sickness, the story would have been remarkable enough, since she was altogether uneducated. But, as a matter of fact, she remembered none of them in health, either before or after her sickness. It was doubtless the activity of the circulation during the access of fever which brought out as it were the impressions of sounds really recorded in the brain, but so lightly that except during such situation she remained unconscious even of their existence.

A case cited by Dr. Abercrombie confirms the suggestive theory that the stimulus which fever gives to the circulation (sign of disease though it is) may bring dormant mental impressions into temporary activity. A boy at the age of four had undergone the operation of the trepan, being at the time in a stupor from a severe fracture of the skull. After his recovery he retained no recollection either of the accident or of the operation. But at the age of fifteen, during an attack of fever, he gave his mother an account of the operation, describing the persons who were present, and even remembering details of their dress and other minute particulars.

Even an accident may stimulate the memory in such sort as to recall long-forgotten neutral impressions, and so to convey that the mind is regularly retentive. Dr. Abercrombie relates a case of this kind which suggests many perplexing problems in regard to memory. A man who had been completely stunned by a blow on the head remained still partially out of his mind when he had recovered from the first effects of the blow. In his unconscious state he spoke a language which nobody in the London hospital to which he had been removed could understand, but which was presently found to be Welsh. It was subsequently discovered that, though Welsh by birth, he had been thirty years away from Wales when the accident occurred, and had quite forgotten his native tongue. On his restoration to full consciousness he lost his Welsh again completely, but recovered his English.

The effects of an accident—in destroying temporarily, or, so far as it appears, wholly—all neutral impressions received within certain intervals, are sometimes curious enough. Thus Dr. Carpenter mentions the case of a friend of his—a clergyman—who was pitched out of a phaeton, and received a severe concussion of the brain. On recovering he found that he had forgotten all that had happened, not only when the accident actually took place, but during some previous time. The last thing he remembered was that he had met an acquaintance on the road just about two miles from the accident.

An access of fever may produce, as we have seen, a local disturbance of brain functions. It is further worthy of notice also that the recollection a man has of events preceding intoxication is apt to be similarly limited in a definite but not readily explicable manner.

I remember a Cambridge man who, though not given to

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drinking, and now "a sober man among his sons," was more than once overtaken by liquor during the time when he had yet to learn his brain's exceptionally limited power of resisting the action of intoxicants. This man would not only be unable to recall what had happened during the time when he was intoxicated, but a number of preceding events which had taken place while he was still perfectly sober. His friends would tell him of things which had happened a full hour before he was "overtaken" (as the quaint expression has it), which had altogether passed from his remembrance. He used to say that his recollection was clear up to a certain point, beyond which everything seemed "veiled."

But it was clearly shown by an experiment which he arranged for his own satisfaction—being one of the inquisitive sort—that the veiling was, as it were, extended backwards from the time of actual intoxication, for whereas his forgetfulness extended over the whole interval from the first glass of wine (which he always remembered drinking) to the sixth or seventh at which intoxication began, he could remember with accustomary readiness all that happened at a sitting where he had drunk four or five glasses of the same wine. Of course he had to trust to his friends to note for him at what stage intoxication began; in fact, until he had learned this from others he could know little about it, because of the peculiar veiling of past events which took place after he had passed that stage. But his friends not being of the sort who rejoice to see a man under the influence of liquor, he had confidence in them; and besides, he could prove so much as this for himself, that whereas he could never remember more than the first glass if he drank too much, he could drink four or five glasses safely, remembering all that happened. What he could not learn for himself was, how many more glasses he could take without intoxication. At last he could only obtain this knowledge in such sort that he was conscious of it while intoxicated; for his friends found that after the sixth or seventh glass, which produced intoxication, he could always remember every detail of what had happened during previous accessions of the temporary insanity we call drunkenness.

The way in which this man's mind came out from the "veiling" was as strange and as suggestive as the way in which it was thrown under that veiling. I remember being present at the moment when consciousness or sanity (whichever we choose to call it) came back to him. He was a mathematician, and a man had put in his hand to test his condition a mathematical treatise on mechanics, over which my friend had maundered, as drunken men will. Suddenly his mind seemed to straighten up, and, in response to a remark that he was "screwed," he turned to the pages in the book dealing with the screw, and said quaintly, "See here, A. You're a classical man, and know nothing about mathematics; but these angles, Alpha and Beta" (showing a diagram) "represent the pitch of these screws. Now you needn't pitch into me about being screwed, for if I'm screwed at an angle Alpha, you're screwed at an angle Beta." (A. really was at the time the worse for liquor, but the other who had been so a moment before, was, from the moment he had opened the book, perfectly clear-minded, and a few minutes later was at his mathematical studies.)

Mr. NORDENSKIÖLD some time ago received an account from Don Carlos Stolp, of San Fernando, Chili, of his observations of the "red sunsets" of 1883-1884, from a point on the Andes about 15,000 feet above the sea, and afterward Señor Stolp sent some specimens of an atmospheric dust which he had observed at the same time. Analysis of this dust showed that it had no relation to volcanic dust, but that it was of the kind regarded as cosmic dust—containing the iron, nickel, phosphoric acid, and magnesia constituents characteristic of the cosmic deposits. There is, however, no evidence that this dust was connected with the red light.

EDISON'S PHONOGRAPH.

IN answer to questions about his phonograph, Mr. Edison said recently:—

"Perhaps I am wrong in telling you anything about my phonograph, because what I claim for it is so extraordinary that I get only ridicule in return. I am so confident that when the apparatus appears it will dispel all doubts as to its practicability and working value, that I can afford for the present to ignore all kinds of criticism, and keep at my work regardless of the storm which I have been raising by telling a few people that there was such a thing as a perfected phonograph in existence. I am sure that while scientific men may doubt that I have succeeded as well as I say I have, they will admit that there is nothing at all impossible in what I claim, and that the germ of the perfected phonograph, should such a thing appear, is very clear in my old toy of ten years ago, which was exhibited all over the country, and was then acknowledged to be one of the wonders of the century. Just consider for a second what my old phonograph is, and think how little needed to be done to bring it to a working instrument. With my roughly-constructed instrument of 1877 I reproduced all sorts of sounds, getting back from the phonograph something like the original sound. Of course you had to yell into the thing; and the reproduction of conversation was often something of a caricature of the original. Nevertheless, to obtain a result that could be understood was doing wonders; and most people who remember my exhibitions will admit that, while I did not produce a commercial machine, I made a very interesting and creditable attempt, and my whistling and singing phonograph was a wonder.

"There were all sorts of objections in detail to my first instrument. It weighed about one hundred pounds; it cost a mint of money to make; no one but an expert could get anything intelligible back from it; the record made by the little steel point upon a sheet of tin-foil lasted only a few times after it had been put through the phonograph. I myself doubted whether I should ever see a perfect phonograph, ready to record any kind of ordinary speech and to give it out again intelligibly. But I was perfectly sure that if we did not accomplish this, the next generation would. And I dropped the phonograph and went to work upon the electric light, certain that I had sown seed which would come to something. For ten years the phonograph has come up in my brain automatically and almost periodically. I would turn it over and over mentally when I had nothing else to think about. When I couldn't sleep at night, when travelling, when worried about business affairs, I would think the phonograph over and jot down any new ideas for future experiments. Eight months ago I began laboratory work upon it again, and a month ago I stopped because I could see no further improvement to be made. It is a finished machine—simple, cheap, effective, not liable to get out of order, and it does everything that I ever hoped the perfected phonograph might do.

"My phonograph will occupy about as much space on the merchant's desk, or at the side of the desk, as a typewriter does. It will work automatically by a small electric motor, which runs at a perfectly regular rate of speed, is noiseless, and starts or stops at the touch of a spring. Suppose the merchant wishes to write a letter, he pulls the mouthpiece of the phonograph to him, starts the motor with a touch, and says what he has to say in an ordinary tone of voice. When he has done he pulls out a little sheet and rolls it up for the mail. The recipient places this sheet in a similar phonograph, touches the motor spring, and the instrument will at once read out the letter in a tone more distinct

clearer, more characteristic of the voice of the writer than any telephone you or I ever heard. The phonograph voice is not a loud voice, perhaps not more than twice as loud as the sound you get from a good telephone, and an earphone will be necessary. This, however, may not be an objection, inasmuch as people do not always want to have their letters heard all over the office. In aiming for loudness in the phonograph, I went astray in my first experiment; I should have tried for clearness. The present apparatus will satisfy any one who is half-satisfied with the telephone. Of course, there are no disturbances in the phonographic message such as those made by induction along a telephone wire, and, as the apparatus will repeat the letter over and over again, it is possible to understand every syllable, even in a noisy office. I was so overcome with the success of my first instrument, finished about six weeks ago, that I doubted whether I could make another equally good, and I went to work at once to do so. My second instrument works as well as the first, and I have forty workmen employed in making the tools for the manufacture of the first lot of 500 phonographs. They will cost 60 dols. apiece.

"Now for some speculation as to what people may do with the phonograph. I am confident that it will be found in the office of every busy man. I am confident that the editor and the reporter of the future will never think of losing time by writing with a pen or dictating to a stenographer when the printer can set type better from the dictation of the phonograph than he can from copy. I have already perfected an apparatus which allows the phonographic message to be given out in pieces of ten words each. The printer touches a pedal with his foot and the phonograph says ten words. If he sets the ten correctly, he touches the pedal again and gets ten words more. If he is in doubt he tries another pedal, which makes the phonograph repeat. In the future some method may be found of combining the phonograph and the telephone—that is to say, the phonograph may be made so delicate as to take down the sound from a telephone and give it out again when wanted. As yet I have not attempted any such thing. The vibrations of the telephone diaphragm are too delicate for use in the phonograph. In business I think that the phonograph will be used everywhere. Outside of business it is hard to say exactly to what uses it may be put. As it will record and repeat any kind of musical sound, and as the process of duplicating the phonogram, as I call my sheet of metal which has passed through the phonograph and become impressed with certain sounds, is very cheap, the phonogram copy of a lecture, a book, a play or an opera need cost but a trifle.

"For music, I know that you will simply laugh when I tell you what I have done with the two instruments that I have finished. I have got the playing of an orchestra so perfectly that each instrument can be heard distinct from the rest; you can even tell the difference between two pianos of different makes; you can tell the voice of one singer from another; you can get a reproduction of an operatic scene in which the orchestra, the choruses, and the soloists will be as distinct and as satisfactory as opera in this sort of miniature can ever be made. Opera by telephone has been done in Paris and London more or less successfully, but the phonograph will eclipse the telephone for this purpose beyond all comparison, and phonographic opera will cost nothing, because the phonogram can be passed through the phonograph, if necessary, a thousand times in succession, and once the machine is bought there is no other cost beyond the trifle for phonograms. For books, the phonogram will come in the shape of a long roll wound upon a roller. To make the first phonographic copy of a book, some good reader must of course read it out to the instrument; once that is done, duplication to any number of thousand or million copies is a simple mechanical work, easy and cheap. Now, just think a moment what that means.

"Suppose you are sick, or blind, or poor, or cannot sleep. You have a phonograph, and the whole world of literature and music is open to you. The perfected phonograph is going to do more for the poor man than the printing-press. No matter where he is, the poor man can hear all the great lectures of the world, can have all the great books read to him by trained readers, can hear as much of a play or an opera as if he was in the next room to the theatre, and all this at a cost scarcely worth mentioning. I remember that when the telephone was first announced it was said that now people in the wilds of Africa or America might assist nightly at the performances of the Paris Opera House; the wires from that favoured spot might run to all parts of the world. Well, we have not yet got to that, although it is a scientific possibility for the future to perfect in detail. But the phonograph will make such a thing perfectly easy. The phonographic record of a performance of the Paris Opera House can be duplicated by the thousand and mailed to all parts of the world. I don't know but that the newspaper of the future will be in the shape of a phonogram, and the critic will give his readers specimens of the performance and let them hear just how the future Patti did her work, well or otherwise. This sounds like the wildest absurdity, and yet, when you come to think of it, why not? Have I told you enough to make you believe that I am joking? Well, I am nothing of a joker, and this is all the most sober kind of statement. Within two months from now the first phonographs will be in the market."

COLLISIONS AT SEA.

By W. B. ROBINSON, Chief Constructor, R.N. (Retired).

THE interest and importance of the following communication will be recognised by all readers. "Gossip" is omitted this month to make room for this letter, which reached me at my Florida home rather late.—R. P.

"Referring to Mr. Gilbert R. Faith's paper on 'Collisions at Sea' in your November number of KNOWLEDGE, let me say that the article in question has been written under an entire mistake regarding what happens when the rudder of a ship is put over. The effect of putting the helm over when the ship is under way is to tend to make her turn, as she proceeds, nearly around her centre of gravity, and to finally revolve in almost a circle, her speed being lessened till it reaches, with the same horse-power, nearly a fixed quantity. The trials of all the ships of the Royal Navy prove this to be the case; hence Mr. Faith's supposition that a ship, so to say, pivots on her bow, is an error. I send herewith a photograph of the port bow of the *König Wilhelm*, which collided with and sunk the *Grosser Kurfürst*, from which picture it will be seen that the former ship must have struck the latter at an oblique angle with her starboard bow. The photo was taken when the ship was in dock at Portsmouth before the injured bow was touched for fitting a temporary one designed by me. The supposition that ships when turned by their helms pivot on their bows being a mistake, all Mr. Faith's deductions therefrom become erroneous.—W. B. ROBINSON, Chief Constructor, R.N. (Retired)."

[The subject with which Mr. Faith and Mr. Robinson have dealt is so important that it deserves to be very thoroughly ventilated. Mr. Robinson's statements com-

mand acceptance, being based on experiments of a decisive character. They also correspond with theoretical considerations, and I expected, indeed, when I inserted Mr. Faith's interesting and suggestive paper, to find his statements corrected *to some such degree*. For it was manifest to me, viewing the matter merely as a problem in hydrodynamics, that putting a ship's rudder over to either side must tend to cause (apart from loss of way) rotation around a vertical axis passing nearly through the centre of gravity. But I cannot agree with Mr. Robinson that Mr. Faith's deductions become erroneous. On the contrary, Mr. Robinson has proved for us that Mr. Faith's main deduction is sound. If two ships are proceeding on such a course as would bring one slantingly into the side of the other, and they are already close, following the sailing instructions will only make the collision more destructive, unless when the rudder is put over by the latter she pivots round her *stern*—which does not happen. Running directly counter to the printed instructions, would, on the contrary, give her a good chance of escape.—ED.]

MATERIAL OF THE UNIVERSE.

I HAVE just completed a chapter of a book on astronomy, in which I have had to consider the measuring and weighing of the solar system, and I must confess that although I have long been acquainted with the various facts in detail which I have found occasion to discuss in the chapter, I have risen from the study of those facts as thus collected with such feelings of awe at the marvels of our universe, and wonder at man's resolution in mastering the secrets of Nature as I have never before experienced—at least in like degree.

I propose now to run through some of the results belonging to this chapter in the history of astronomy, and then to show something of their bearing on our estimate of the universe, regarded alike with reference to its extension in space and to its duration in time.

Our earth's weight, not estimated by the comparatively rough methods of comparison in which a mountain serves as the counter weight, or the approach towards the earth's centre permitted in a mine is trusted in to indicate the earth's density, but definitely weighed against known masses of matter, amounts to about 590,654,000,000,000,000,000 tons—a mass easily expressed in numbers, but utterly inconceivable by the human mind. The moon, at a distance of 238,830 miles, has a mass equal to about one eighty-first part of the earth's; but even her smaller mass is as hopelessly beyond our powers of conception as that of the great globe on which we live. I am not sure but that, looking on the moon as she rides high above the horizon and noting how small she looks, queen though she be of the orbs of night, there is not something more impressive in the thought that that calmly beautiful globe contains 7,300,000,000,000,000,000 tons of such matter as makes the mass of our earth, than even in the consideration that our earth weighs nearly eighty-one times as much. The earth had always seemed the very emblem of stability and massive might, insomuch that though man in his days of ignorance imagined comparatively narrow limits to his terrestrial domain, there were hardly any limits to the mass or quantity of matter he might attribute to her. But the full size of the moon is visible to every human eye; and the contrast between the apparent and the real is much greater when, for example, we consider that that silvery surface at which we look yonder is 2,160 miles in diameter and contains 7,300,000 square miles of just such rock surface as we have on our earth, than when, looking out upon our earth as far as the eye can reach, we learn that the real extent of the earth is many thousandfold greater than the area thus surveyed. And if this is so in striking degree in regard to the moon's apparent size, it is still so in more impressive manner when we consider her mass.

Passing beyond the moon to the region of space outside, we may turn at once to the sun. Within his fiery globe lies very nearly the whole mass of the solar system. He looks no larger than the moon, but he is 60,000,000 of times larger, and more than 26,750,000 of times as massive. His mass surpasses our earth's 330,500 times, a disproportion of whose full meaning we can only form a fair idea by considering separately first the inconceivably large mass of the earth, and then the enormous number represented by the figures 330,500. On this last point I may remark that few (so far as my observation has gone) form definite conceptions of the meaning of large numbers, even when such meaning is well within their power of appreciation.

To most men 300,000 is a number which, even when it represents money, is not definitely differentiated in the mind from such numbers as 200,000 or 400,000, or even from such numbers as 30,000 or 3,000,000. Yet there are simple ways of obtaining a clear idea of what it represents. Draw a straight line 10 inches long, and, completing a square on it, divide up this square into 100 small squares by lines 1 inch apart drawn parallel to the sides. Take a corner square, and, dividing its sides into tenths of an inch, divide it like the large one into 100 small squares. Then the meaning of the number 10,000 is very clearly shown so soon as we notice that our 10-inch square contains 10,000 such squares as make up the 1-inch corner square. The eye *sees* in this case the degree in which 10,000 surpasses 1; and we all know the truth of old Horace's saying, *Segnius irritant animos demissa per aures, quam quæ sunt oculis subjecta fidelibus*. It is now easy, without further drawing, to imagine ten such squares as our large one, and thus to recognise the significance of the number 100,000. Thirty such squares would picture the meaning of 300,000, the small tenth-of-an-inch square in the corner being the unit. And thus we can readily form a good mental conception of the degree in which the sun's mighty mass surpasses the earth's—though we still remain, and must for ever remain, unable to appreciate the stupendous significance of the six hundred millions of millions* or so of tons contained within the bulk of our terrestrial home.

* According to our English system we call this six hundred trillions. In America the expression would be quintillions. I object altogether to use an expression which has no true significance. It includes the number 5 (quint); but no 5 is logically includible in it. A quintillion, according to the English system of numeration, signifies a million raised to the fifth power; according to the American (want of) system, it signifies a million multiplied by a thousand raised to the fourth power. One can get a 5 in, indeed, thus: A quintillion is a thousand multiplied by a thousand raised to the fifth power; but that is an obviously unsymmetrical way of representing a thousand raised to the sixth power. If the American system were sound logically and mathematically, it would not be so convenient as the English system, for when we get into such numbers as trillions, quadrillions, and so forth, which only happens when we are comparing numbers all of which are very large, it is desirable not to confuse comparison by having too many different names, or (which is the same thing) by separating our classes of numbers by divisions too closely set. Lastly, in giving names to large numbers the English system is superior to the American, though there is no difference in the numbers of words employed. The first example, taken at random, will serve to show this to the logical arithmetician. Let the number be 324,565,482,793,812,456,259: for this the American name would be three hundred and twenty-four quintillions, five hundred and sixty-five quadrillions, four hundred and eighty-two trillions, seven hundred and ninety-three

One of the most impressive thoughts respecting the sun's mass is the might which it represents—might absolutely essential to his rule over the solar system. To give by a simple example an idea of the sun's tremendous power, imagine an immensely powerful magnet acting at a distance of one mile on a particle of iron, and try to conceive the slow motion by which at first that particle would respond to the magnetic attraction. Now suppose this magnet replaced by a body having the sun's attractive might, but all collected in a one-inch globe; and suppose, further, that this concentrated sun acts on a body from the distance of a mile all the time (a whole second is all the time I ask for), retreating from the body as, under its attractive influence, the body moves towards it, and so always maintaining that distance of one mile unchanged. Then, in that second, the attraction on the body would be so great as to communicate a velocity of 31,600 millions of miles per second. Or, in a period of time so inconceivably short as one millionth part of a second, our sun's mass, concentrated into a one-inch globe, would at a mile distance (kept unchanged) communicate the tremendous velocity of 31,600 miles per second.

Our sun surpasses in mass all the members of his family together more than 745 times, so that there is no question of his absolute supremacy over that family. Yet Sir John Herschel fell into a mistake when he asserted that, if all the planets were in a row on the same side of the sun, each at its proper mean distance from the sun, the centre of gravity of the whole system would lie far within the globe of the sun. The centre of gravity would be 937,000 miles from the sun's centre. This does not prevent the sun from exerting supreme sway over the planets, however. Indeed, the fixed centre round which the sun and all the planets travel—this centre being the centre of gravity of the solar system at the moment—is nearly always within a much smaller distance from the sun's centre than I have just named, since it very seldom happens that even three of the chief planets of the system conjoin their influence on the same side of the sun. The sun's motion around the common centre may be regarded as made up of motions in a nearly circular ellipse at a mean distance of 460,000 miles due to Jupiter's attraction, in another at a mean distance of 253,000 due to Saturn's attraction, and in two others at mean distances of 79,000 and 145,000 miles respectively, due to the attractions of Uranus and Neptune, all other attractions being relatively inappreciable.

And just here I cannot but touch, in the way of correction, on the strange mistake made by my friend Mr. Mattieu Williams in imagining that the motion of our sun in the path thus determined, about the common centre of gravity of the solar system, can in any appreciable degree affect the condition of the sun's interior. He has presented in his suggestive book, "The Fuel of the Sun"—a book full of novel ideas, but not free from startling mistakes—the quaint notion that as our sun goes circling round and about the common centre of gravity of the solar system, his material is swayed about with all sorts of effects and influences, stirring it up, intermingling it, keeping it active, and so forth, as might happen, for example, if the glowing fuel within some great furnace were constantly stirred up by the swaying round of the whole furnace by some powerful mechanism. The mistake is, perhaps, a not unnatural one. Something akin to it was made even by so skilful a mathematician as Professor Simon Newcomb, when, in the first edition of his "Popular Astronomy," he presented the tides as a product of centrifugal tendencies called into action as our earth circles around the common centre of gravity of the earth and moon.*

Mr. Williams's idea about a stirring up and shaking together of the solar fuel is entirely erroneous. If the sun were swinging bodily round a fixed axis, in such sort that while some parts of his mass (being near to that axis) moved much, there would result a certain stirring up of the solar material which might, for anything I know to the contrary (though I have given no attention to so purely hypothetical a case), have some such effects as Mr. Williams imagines. But there is no such swinging. The sun moves as a whole (with inconceivably slow motion, too), around or upon his somewhat complex orbit, each particle moving in an orbit of exactly the same size, so that there is no relative motion among the different parts of his mass, and therefore no strains or pressures are produced and no interchanges of position occur.

I imagine that few recognise fully the next most striking feature of the solar system after the amazing superiority of the sun's mass—I mean the startling discrepancy between the outer family of planets and the inner. Each contains four primary bodies—Jupiter, Saturn, Uranus, and Neptune forming one, Mercury, Venus, the Earth, and Mars forming the other. But while the combined mass of all the four inner planets is not quite twice the mass of the earth, the four outer planets together exceed the earth in mass no less than—in round numbers—450,000 times. Can we possibly regard two families so disproportioned as resembling each other in kind? I have been engaged now so many years in endeavouring to persuade students of astronomy, both on *à priori* grounds and on the more satisfactory evidence of observed facts, that the giant planets are unlike the terrestrial planets even as they are unlike the sun, each forming a definitely distinct class, that though I may say I have now succeeded, I can hardly expect very readily to persuade the general reader that Jupiter and Saturn must be altogether

billions, eight hundred and twelve millions, four hundred and fifty-six thousand, two hundred and fifty-nine; the English name for the same number is three hundred and twenty-four trillions, five hundred and sixty-five thousand four hundred and eighty-two billions, seven hundred and ninety-three thousand eight hundred and twelve millions, four hundred and fifty-six thousand two hundred and fifty-nine. Each name contains forty words, but the English, with its hundreds of thousands of trillions, billions, millions, and units, is much more systematic, and conveys a much clearer idea than the American with its hundreds of quintillions, quadrillions, trillions, billions, millions, thousands (observe the entire change in the character of the nomenclature here), and units.

I think it hardly necessary for me, after now some fourteen years, during which I have shown the utmost readiness to appreciate things American at their full value—a readiness which many among my fellow countrymen regard as extreme and unpatriotic (though that is nonsense)—to explain that it is from no desire to find fault that I thus dwell upon the unscientific and illogical nature of the system of numeration adopted in American schools. The system, employed as it now is, throughout the whole of the great American section of the English-speaking race, involves serious inconvenience from the mere fact that it differs from that employed elsewhere where English is spoken and written. Probably when it was introduced American arithmeticians hardly looked forward to the time when America would take so large a share of the scientific work of the English-speaking races as she does at present.

* I was rather interested in this mistake, because on the strength of it, and a kindred mistake about the earth's reeling motion in 25,868 years being similarly caused, I had been taken sharply to task by the editors of "Johnson's Cyclopædia" for not introducing some such explanation of the tides and of precession into the astronomy of the "American Cyclopædia." Here, wrote my severe and anonymous critic (or to this effect), was our American astronomer, all ready with a new cut-and-dried explanation of these phenomena, and Messrs. Appleton pay this "blawsted Britisher" for reproducing the old one. The old one, however, chances to be right; the new one (as it appeared shortly after in the first edition of "Newcomb's Astronomy") is wholly wrong; and even in the very mild and modified form in which it appears in the second edition, it has no value whatever as an original explanation, being only a recondite way of presenting the most unsatisfactory portions of the old one.

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unlike our terrestrial home, and must have had in the past, as they will have in the future, quite different life histories. But such is certainly the case. It might be inferred from what we know of the disproportion of the masses, and all the more certainly from what we have recently learned to consider extremely probable respecting their general resemblance in structure. (For, unlike collections of unlike materials might by some strange chance have like life histories; but such similar life histories could never occur in unlike collections of like materials, or in like collections of unlike materials.)

It is, however, noteworthy how, even within each family of planets—the family of giant planets and the family of terrestrial planets—differences of size and mass exist which suggest marked differences of life history, and also enable us to infer from analogy great differences among the component members of higher systems, as sidereal systems, systems of such systems, and so on to higher and higher orders endlessly. I have said that the whole of the inferior family of planets is less in mass than twice our earth; in other words, our earth surpasses all the rest put together. Venus in turn surpasses Mars, Mercury, and the moon together; Mars surpasses Mercury and the moon together; each member of the family, in fine, surpasses all those less than itself taken together. Turning to the family of giant planets, we find the same law there. Jupiter surpasses Saturn, Uranus, and Neptune together some two and a half times; Saturn surpasses Uranus and Neptune together more than threefold; Neptune surpasses Uranus and all the rest (moons, rings, &c.) of the outer system, with the whole system of terrestrial planets and satellites thrown in.

(*To be continued.*)

LARGE TELESCOPES.

I HAVE been glad to notice that my friend Professor Young has come round to the opinion I have been somewhat strenuously maintaining, that the great telescopes which have lately been made are capable of better and more interesting work than hitherto has been accomplished with them. I have not seen yet the article itself in the *Forum*, wherein Professor Young has indicated the value of great telescopes, and the way in which work done with them can increase our knowledge and extend the horizon of astronomy; but I have before me a characteristic passage from his essay, the tone of which shows clearly that Professor Young fully indorses the views I have expresed respecting the fine telescopes made so skilfully by the Clarkes and others, and (in several cases) presented so generously to astronomers by men or societies of adequate means.

"The reasonableness of wanting larger telescopes still," says Professor Young, "is identically the same as that of wanting a telescope at all." This, though somewhat tautologically expressed, is in reality the essence of the whole matter. Astronomy wanted telescopes that more of the universe might be seen and studied, and as far as possible understood; and each increase of telescopic power has come in response to the longing of astronomy for a wider range of view, increased insight and better understanding of the wonders which lie concealed from ordinary vision in the remote depths of space.

When one of these far-seeing eyes of astronomy, promising keener vision than had yet been attained, has been provided, and when one of the observing army of astronomy has been set in charge of it, high expectations are naturally formed respecting the work it will accomplish. No one who understands optical laws can for a moment doubt that such a telescope will do more than one of inferior light-gathering power. This is so, even though a smaller instrument be to some degree superior in actual quality; but as a matter of fact our opticians are improving year by year the quality of their instruments while increasing the size of the great eyes they make for scanning star-strewn space. Accordingly astronomy has a right to expect that, even though no actual discoveries may be made by means of a new telescope of superior qualities, the details of objects already known will be better examined, and so be more fully understood.

As Professor Young well says, "It is not possible now to go out at night as some seem to think"—who must be entirely ignorant of the work astronomy has already done—"and pick up discoveries as one would gather flowers in a forest; but we may be sure of this," the large telescope "will collect data, with micrometer, camera, and spectroscope, which will remove many old difficulties, will clear up doubts, will actually advance our knowledge—and what is still more important, will prepare the way and hew the steps for still higher climbing towards the stars." The last half sentence may have more metaphor than meaning, more rhetoric than reasoning; but though we may not quite know how much Professor Young really means by hewing out steps for climbing towards the stars (after all this is not more highfalutin than Horace's "star-striking with his sublime top"), his main argument is sound. A larger telescope, even when used only for going over ground already surveyed with smaller ones, is capable of doing most important and valuable work. The small telescope may discover objects, precisely as the naked eye discovered the sun and moon and planets; but the larger one will show better what those objects really are, revealing details which before had been either wholly unseen or so imperfectly seen as to be misunderstood. A larger telescope still will show the details of those details, and fresh details, to be still further and more completely analysed when higher powers are applied—*if only the larger telescope is zealously applied to such work.*

Many interesting examples might be cited of the way in which large telescopes properly used complete the work begun by smaller ones.

Consider, for example, the discovery of the strange Saturnian appendage which we now know as the ring system of Saturn. As every one knows, it was Galileo, with his little telescope, who discovered that Saturn had something about him which was unlike anything yet seen. Old Saturn, said Galileo, in his fanciful way, has two satellites which attend him on his way. Later, in a more businesslike communication to Kepler, he said:—"Saturn consists of three stars in contact with one another." And last, addressing the world of science, he announced that he had observed the remotest (or the highest, "as it was still the fashion to call the most distant) planet, to be triform—*altissimum planetam tergiminum observari.* Such was the discovery of the Saturnian ring-system. No larger telescope could rediscover it; but every increase of telescopic power applied to Saturn has taught us something more about the system. Galileo was never able to understand why the attendants who guided Saturn on his way were so variable in aspect, and still less why, when he looked at Saturn in 1612, he could see no attendants at all. Hevelius, with larger instruments went some way, but not very far, towards interpreting the mystery. He analysed as well as he could the Saturnian changes, and this is his sesquipedalian report of the results he obtained: "Saturn," said he, "presents three various figures to the observer—to wit, in manner following:—first, the monospherical; secondly, the trispherical; thirdly, the spherico-ansated; fourthly, the ellip-

tico-ansated; fifthly and lastly, the spherico-cuspidated," of which many a popular reader in those days might have remarked—if there had been popular readers then—what Gilbert's devoted lover remarks of the Tupperian sentiment:—

> "A fool is bent upon a twig, but a wise man fears a bandit,"
> Which I know was very clever, but I couldn't understand it.

Hevelius meant simply, however—though he expressed himself anything but simply—that Saturn looks sometimes like a globe, sometimes like three globes, sometimes like a globe with handles, sometimes like an egg with handles, and sometimes like a globe with projections. Further telescopic research by Huyghens showed that Saturn is surrounded by a flat ring inclined to the plane in which the planet travels. Cassini's larger telescopes showed the ring to be double; further researches disclosed divisions in the outer ring; then the inner dark ring (semi-transparent, so that the planet's outline can be seen through it) was discovered; and with each increase of telescopic power fresh discoveries were made, which are going on still, and will doubtless continue to go on for a long time yet to come.

Only it is to be observed of this case, as of all such cases, that if each astronomer who was put in charge of each new telescope had been unwilling to examine with it the Saturnian ring-system because already some one else had discovered such and such details, all this pleasing progress would have been brought to an end. It will presently be seen why I dwell on this rather important consideration.

There is scarcely an object of telescopic study which has not in some such way rewarded each increase of telescopic power and each fresh inquiry by keen-sighted and earnest observers. Every planet either shows more of detail, or shows the details of its surface more clearly, or shows that details supposed to have been seen have no real existence when increased telescopic power is applied to its examination. The stars not only appear in greater numbers under such increase of power, but single stars are resolved into double, triple, or multiple stars; minute companions are resolved into sets of attendants; and movements are detected and measured which with smaller telescopes might have escaped notice, or only been recognised after a much longer time had elapsed. The star clouds or nebulæ are seen in greater detail with larger telescopes, and indeed many new nebulæ are usually discovered when higher telescopic powers than had before been used are applied to the search for them. The structure of comets is more and more clearly shown as larger telescopes are used in the study of cometic mysteries. And last, to return to our more immediate neighbourhood, the study of the sun and moon has progressed very obviously and decidedly as larger telescopes have been applied to the details of the surface of either orb.

I may take the examination of the sun's surface as illustrating in a very effective way the advantages to be derived from the use of large telescopes.

Galileo, Scheiner, and Fabricius could recognise little more than the fact that the sun has spots on his face at times, and that these spots are carried round in such a way as to show that the sun rotates on his axis. Hevelius noted the *maculæ* or mottling, and the *faculæ* or bright streaks. Wilson recognised the changing appearance of the spots, and the evidence that they are depressions. The elder Herschel recognised the corrugations. Nasmyth called attention to details which he called the willow-leaves, comparing the appearance to that which would be produced if a number of luminous objects of a form somewhat resembling that of the willow leaf were strewn on a somewhat darker ground. Dawes and Huggins showed that with better telescopes the appearance of a bright network on a darker background gave place to that of a darker network on a bright ground, and this appearance in turn to that of a number of bright grains strewn more or less irregularly over a surface which, though relatively darker, is in reality intensely bright; and lastly, Langley has shown, by yet more careful scrutiny, that these grains, the so called rice-grains, are irregular in shape; that they become elongated in the neighbourhood of spots, and that a number of forms akin in variety alike of individual shape and of combination to the cloud-forms—cirrus, cumulus, and nimbus, cirro-stratus, cirro-cumulus, &c.—seen in our skies can be recognised in the glowing photosphere of the sun. Nor can we yet tell how much more of detail, or, therefore, how much more of significance may come to be recognised hereafter in the structure of the great ruling centre of our system.

But if new telescopes of increased power are to do what they are unquestionably capable of doing, and what astronomy is entitled to expect of them, there must be no perfunctory control of the observatories in which they are erected. There is a danger (which we have recognised in the old country, and which exists, I fear, to some degree in America also) lest the large telescopes should come to be spoken of more for what they are capable of doing than for what they are doing or have done. There is further danger lest smaller telescopes alone should be busily employed, and this rather to encourage the construction of important observatories, capable of splendid work (provided with large telescopes and also managed by persons capable of drawing large salaries), than with any great desire to advance astronomical knowledge.

We have had in England one or two such marked examples of this sort of thing that (knowing human nature to be everywhere much the same) no true lover of science can fail to feel somewhat anxious lest in America also the same thing might happen. Such men as Mr. Huggins, in England, and Dr. Henry Draper, in America, doubtless enable us to entertain the hope that men like the Newtons and Herschels of past times are still among us, who are capable of working zealously at science for science's own sake.* When on the other hand we find, as we have in England, men skilful as observers making their really clever researches a sort of fulcrum for levering up a well-salaried post, and either when such post has been secured or when all hope of securing it has failed, dropping altogether their zeal for science, we begin to recognise a danger which threatens seriously the future of our big telescopes. I mean the risk that they should fall into the hands of men who have no genuine zeal for science, even though in the past they may have done good work in research. Such men there have been even among astronomers, men who have, indeed, regarded large telescopes as instruments by which remarkable discoveries might be accomplished, but who have cared for such discoveries only as stepping-stones for themselves.

* I am quite aware, even as I write these lines, that William Herschel, and in less degree John Herschel, availed themselves of the power that science gives of earning a livelihood, or even of maintaining a family, through some development of scientific research. William Herschel made telescopes for sale, and John Herschel wrote books, from the sale of which considerable sums accrued to himself and to his family. Even if the Herschels had held, as Newton did, salaried posts for work associated with science, it would in no sense have affected the distinction I draw between them and men who value scientific research *only* as a means for gaining money. Self-support, and the maintenance of those dependent upon one, are duties which come before even the advancement of science. But we see Newton's zeal for science showing itself in work done independently of all possibility of profit. William Herschel gave up remunerative business that he might devote his whole time to astronomy, on the merest chance that a portion of his scientific work might avail for self-maintenance.

XUM

I could cite, with names and dates in full and ample documentary evidence, a case which for a while created a good deal of excitement in the old country—where the suggestion was definitely made to Government that, because X had made several clever observations and a few interesting discoveries, and because X's name had thus (most men scarcely knew Y) become widely known, he should have not only a new observatory but a new kind of observatory made for him, whence he should make more observations, for only 2,000*l.* (say 10,000 dols.) per annum. It was made clear to those who for a while were rather pleased with the thought, that if X were really zealous for astronomy, the mere command of a telescope of greatly increased power would be felt by him to be an ample reward for past work, or that at least he would seek only for the means of supporting himself in comfort, *not* to be paid a lavish salary for a part only of his time. So—

> The scheme fell through,
> It would not do.

But thoughtful men noted the danger then escaped; and in England, at any rate, they will in future think twice before they plan new observatories and provide new salaries in pursuance even of the most plausible schemes for what has been pleasantly called the "endowment of research."

It is unfortunate that the question of making and using large telescopes cannot be readily dealt with without the introduction of questions so sordid (for though there is nothing sordid about self-maintenance—while the maintenance of family is a sacred duty—jobbery is *always* sordid); but the fact remains. Those who wish to see great observatories and fine telescopes doing the work of which they are capable, have generously, though somewhat thoughtlessly, concluded that the best way is to offer very high remuneration in order that the services of the best men may be secured. Unfortunately such generosity is apt to defeat its own ends. The men who jump at such offers are not apt to be the men most anxious to advance the cause of science.

How would it be if a course the reverse of this were adopted? if instead of saying, "We will offer such and such advantages, and salaries so high, that we may be sure of securing the services of the best astronomers," those who generously provide means for erecting great observatories were to say, "*We are sure to get the services of earnest and zealous astronomers if we offer all that is wanted in the way of scientific appliances—and nothing more*"?

Apropos of Mr. Lockyer's latest novelty, his "Preliminary Note on the Spectra of Meteorites" summarised (!) in five columns of the *Times* of November 18, and made the subject of a good advertising leader in the same issue, we must express our surprise at the absence of any reference to the remarkable phenomenon reported from Clayton (Ga.) in the shape of an aerolite which fell there, and on the polished surface of which was a deeply graven circle, within which was a four-pointed star, a representation of a bird-reptile, resembling in a measure the extinct archæopteryx, and a great number of smaller figures resembling those used in modern shorthand! An analysis of a fragment reveals—at least, so "H. Randolph Stevens, analytical chemist," tells us—the presence of a "new element." We can readily believe this. There must be many "new elements" in the matter, and we await with interest the promised official report, which will probably be drawn up by Captain Lawson, the author of "Wanderings in New Guinea," and his friend, a descendant of Baron Munchausen. Really, Mr. Lockyer must look to his laurels.

ROYAL VICTORIA HALL.

(*To the Editor of* KNOWLEDGE.)

THE Tuesday Popular Lectures for the last four weeks have presented much variety in their subjects. First, Sir John Lubbock gave his hearers an amusing collection of the oddities of savage life. This was followed by a mountaineering excursion to Switzerland and the Caucasus, under the guidance of Mr. Donkin, hon. sec. of the Alpine Club. We say advisedly an excursion, for the splendid photographs did all that was possible to bring snow peaks and glaciers into the presence of Londoners who could not go in search of them. Then Professor Boyd Dawkins told the ever-marvellous story of our coalfields, and finally Dr. W. D. Halliburton gave a lecture on "The Eye and How we See."

He gave a very clear and well-illustrated account of the structure of the eye, then explained so much of refraction as was necessary to understand the action of lenses, and the passage of the rays of light to the retina. He alluded to the long-standing puzzle of upright vision, and remarked that there is some reason to think that we see in virtue of a temporary photograph on the "visual purple," which is for the time being bleached by light. If a frog (the animal in which this visual purple is most developed) is decapitated in front of a window, a white inverted image of the window will be found on the visual purple of his retina. Passing on to defects of vision, Dr. Halliburton explained the causes of long and short sight, and the action of the appropriate spectacles, and insisted on the importance of attending to inflammation of the eyelids in babies, lest opacity of the cornea should result—the most frequent cause of blindness. Finally, he spoke of so-called colour-blindness, or the inability to distinguish between colours, especially red and green, which proves on investigation to be so common that it is a serious source of danger at sea and on the railway. Possibly many unexplained collisions may be due to misreading of signals on this account. One narrow escape is known to have taken place. Two vessels were nearing each other at night, with the usual lights displayed. But it happened that on board one of them both mate and steersman were colour-blind, and a collision must have taken place had not the captain happily overheard the order given, rushed on deck, and, knocking down the man at the wheel, altered the ship's course just in time.

The lectures will be resumed, after the Christmas entertainment, on January 10, when Mr. Stradling has promised a lecture on "The Great Sea Serpent," illustrated by living reptiles. He will be followed on successive Tuesdays by Mr. Rudler (president of the Geologists' Association) on "Caves and Cave Men"; Professor Bonney on "Early Modes of Burial in Bretagne"; and Professor Ramsay on "Early and Later Alphabets."

C. A. MARTINEAU.

1 Clifton Place, Sussex Square, W.

CAUSES OF IDIOCY.—Dr. T. Langdon Down, inquiring into the causes of idiocy, has found that intemperance of parents is one of the most considerable factors in producing the affection. His view is confirmed by some French and German investigators, one of whom, Dr. Delasiauve, has said that in the village of Carême, whose riches were in its vineyards, ten years' comparative sobriety, enforced by vine disease, had a sensible effect in diminishing the cases of idiocy. Nervous constitution and consumption exercise important influence. Of the professions, lawyers furnish the smallest proportion of idiots, while they are credited with the procreation of a relatively very large number of men of eminence. With the clergy these proportions are more than reversed. The influence of consanguineous marriage, *per se*, is insignificant, if it exists.

THE SOUTHERN SKIES.

MAP XV.—FOR DECEMBER, JANUARY, AND FEBRUARY.

THE NIGHT SKIES IN THE SOUTHERN HEMISPHERE (LAT. 46° TO 24° S.)

AND THE

SOUTHERN SKIES IN ENGLAND (UPPER HALF OF MAP ONLY) AT THE FOLLOWING TIMES:

At 1 o'clock, morning, Jan. 7.	At 11 o'clock, night, Feb. 7.	At 9 o'clock, night, Mar. 8.
„ 12.30 „ „ Jan. 15.	„ 10.30 „ „ Feb. 14.	„ 8.30 „ „ Mar. 15.
„ Midnight, Jan. 23.	„ 10 „ „ Feb. 22.	„ 8 „ „ Mar. 23.
„ 11.30 o'clock, night, Jan. 30.	„ 9.30 „ „ Mar. 1.	„ 7.30 „ „ Mar. 30.

STAR MAGNITUDES.

First . . . . ✱ Second . . . . ✱ Third . . . . ★ Fourth . . + Fifth . . . . ▲

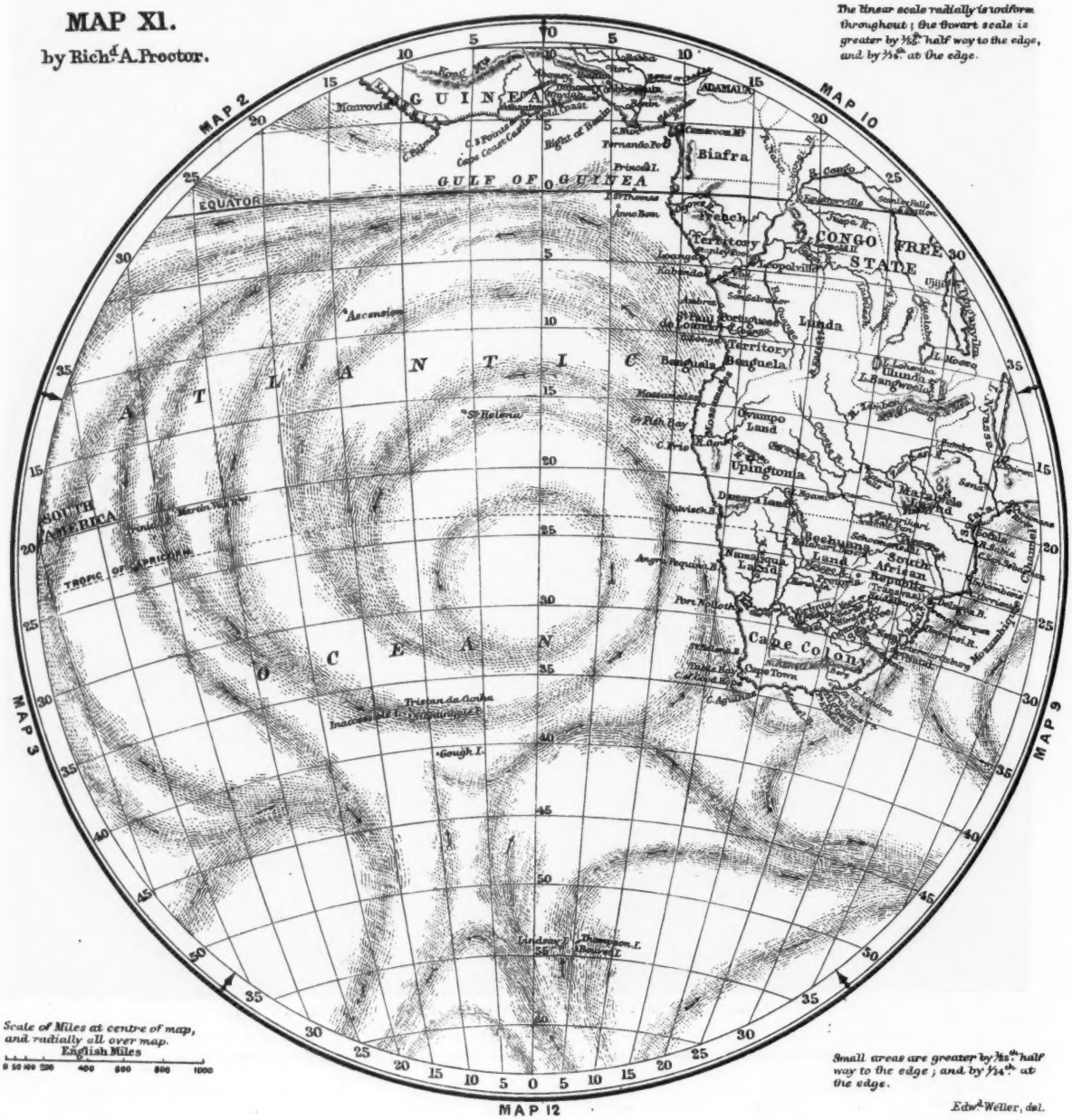
XUM

THE ONE-SCALE ATLAS.

MAP XI.

by Rich.d A. Proctor.

The linear scale radially is uniform throughout; the chart scale is greater by 1/38th half way to the edge, and by 1/16th at the edge.



Scale of Miles at centre of map, and radially all over map.

English Miles

0 50 100 200 400 600 800 1000

Small areas are greater by 1/38th half way to the edge; and by 1/14th at the edge.

Edw.d Weller, del.

COAL.

By W. MATTIEU WILLIAMS.

THE DRAINAGE AND PUMPING OF COAL-MINES.

THE vexed question of the duration of our coal-fields would have been quite settled ere this, had our means of removing the water from coal-mines remained as they were previous to the inventions of James Watt. As I long ago explained, the end of our coal-digging will occur long before our coal-seams are exhausted, long before the physical possibilities of working the coal are exhausted. It will be determined commercially when the cost of obtaining coal at home exceeds that of importing it from abroad, or of the growing of wood. With the tread-wheels, horse-gins, water-wheels, and other pumping-machines that were in use at the beginning of the last century applied to our present workings, coal would now cost far more than firewood, and, even with the steam-engines that preceded those of Watt, it would cost nearly as much. As it is, in spite of all our improvements, there are great well-known coal-seams remaining unworked, and practically unworkable, for the simple reason that the cost of removing the water added to the ordinary cost of coal-getting would exceed the market value of the product. All this coal is, in colliers' expressive language, "drowned out."

If coal-seams occurred in non-porous rocks, such as granite and compact limestone, like the marble of Carrara (where I have walked a couple of miles underground without seeing water), no drainage nor pumping would be required, but this is far from being the case; the characteristic rocks of the coal measures are porous sandstone and shale. Here and there are alternating strata of what the sinkers call "metal," or hard compact rock practically impenetrable to water, but for the most part the rock above the coal permits the infiltration of much of the rain water that falls on the surface. That which oozes or pours through the sides of the shaft may be restrained by "tubbing," as already described, but the water that comes through the roof and sides of the roads and workings must be first collected by drainage and finally removed by pumping or hauling to the surface. There are some few dry coal-mines, of which I shall speak hereafter.

The drainage is effected by the simple device to which I have already alluded, that of beginning to work on the deep, *i.e.* at that part of the estate where the coal is deepest, and then proceeding upwards along the natural slope of the seam. The water may thus run down the roads or by special drains or "water gates," until it reaches the shaft, which is sunk to a considerable depth beyond the lowest opening of the roads in order to form a sumph or receptacle for the water, from which sumph it is drawn by winding buckets or pumps.

Some primitive coal-mines were drained without any winding or pumping. This is possible wherever the seam occurs in hilly districts and lies at a higher level than the bottom of the valley. In such cases, an adit-level, *i.e.* a narrow tunnel, may be cut from the lowest part of the intended working, through the side of the slope, into the open valley. The water, of course, flows down this into the river, or in some cases directly into the sea. This is still used wherever the configuration of the country renders it possible, but unfortunately for the present generation, our forefathers have nearly, if not entirely, exhausted such deposits of coal. It is in lead and copper mines that adit drainage is now more available.

I need not describe the mechanism of pit-pumps—pumps are pumps everywhere, and are properly described in treatises on such machines. The special feature of coal-pit pumps is their great size in some instances, and the depths from which they raise the water. In old times, when only the seams of coal near to the surface were worked, the simple so-called "suction pump" was used, acting, as in these post-Torricellian days we all know, by the pressure of the atmosphere. But this pressure could only sustain a little more than a 30-feet column of water, and therefore at greater depths, pumping by successive stages, or the use of lift-pumps or force-pumps was adopted, or more commonly in the early days the water in the deeper pits was raised by winding, by using large buckets that dipped into the "sumph" in the manner I described when on the subject of pit-sinking.

Costly as may be the raising of water from coal and other mines, its costliness has made mankind the richer. This cost was the chief stimulant to invention in the birth and growth of the steam-engine. The primitive machines of Papin, Savery, Newcomen, Leupold, Beighton, and Smeaton were constructed for pumping water from mines, and the first efforts of Watt with his separate condenser were devoted to the same object. There was a double advantage in this. Not only was the engine especially suitable for such work, but such work reacted with special benefit on the engine which had to overcome a greater deadweight than that of water down in the darkness of a pit sumph. The deadweight of prejudice had also to be lifted out of the still lower and darker depths of human stupidity, and the inventions brought to the light in spite of the resistance of vested interests. The damaging power of these detestable agents was proved by the fact that they crushed Dud Dudley's great invention of the manufacture of iron by pit coal and ruined the inventor, thereby causing a halt of about a century in the progress of this important branch of industry.

The impossibility of crushing the steam-engine and its inventors arose from the fact that its work in pumping water from mines was so easily and obviously measurable. The quantity of water raised from a given depth by the expenditure of a given amount of fuel admitted of such definite statement that misrepresentation was drowned by it.

A few figures indicating the progress we have made in this direction will be interesting. When Smeaton commenced his improvements, the average *duty—i.e.* the number of pounds of water raised one foot per bushel of coal consumed was 5,590,000. In 1772 he erected an engine at Wheal Busy which attained a duty of 9,450,000. But presently—*i.e.* between 1776 and 1779—he was beaten by Watt, and admitted that Watt's engines performed double the duty of his own. Some were tested, and proved to reach 19 millions, and the average of Watt's engines in Cornwall amounted to 17 millions. Finally, his engine at Herland attained 20 millions, and Watt was satisfied, pronounced his work perfect, and expected no further improvement. But in 1823 the proved duty had reached 28 millions, in 1843 it had grown to 60 millions, and now we even exceed 100 millions; the record of an engine erected at Fowey Consols Mine having, while worked under strict supervision during twenty-four hours, attained a duty of 125 millions. Such maximum duty is attained in Cornwall, where coal is dear, and the men in charge of the engine are (or were) rewarded according to the duty they obtained. Not so in the Black Country, where coal is so ruinously cheap, and no record of engine duty is kept.

When a seam is worked out and left, the old workings usually become filled with water, and such occupation of the

space limits the amount of collapse of the rock. But such working out may be only effected commercially—*i.e.*, the working may only be carried to the limits of the estate or royalty, not to that of the seam. Thus the same seam may be opened again on an adjoining estate, and the new workings brought close upon the boundary of the previous workings. When this is the case, great caution is necessary, the law demands that a bore-hole shall be driven forwards (six feet ahead if I remember rightly) in order to feel for the water. A serious accident occurred at Leeswood, in Flintshire, while I was there. This precaution had been neglected; an old abandoned working was broken into by the pick, and through the breach a flood of water poured, drowning seven or eight men.

Much of the coal which is now lying drowned out might be made available by co-operative pumping. This is the case where a large area is held by different landlords, and is so situated, as regards level, that neither estate can be pumped without pumping all the rest, and each refuses to pump for the benefit of his neighbours. Possibly this difficulty will be ultimately settled by the Government taking possession of the whole, and working it for the benefit of the nation; pumping all, and charging dry royalty to pay for the pumping. In this case "royalty" would return to its original signification—viz., payment to the king.

AMATEUR PHOTOGRAPHIC EXHIBITION.

THE annual exhibition of amateur photographic work held by the London Stereoscopic and Photographic Co., Limited, has become an event looked forward to with great interest by all amateur photographers and those interested in the progress of photography. The present exhibition, now open at 108 and 110 Regent Street, is quite as interesting as its predecessors—and, in fact, to one who has visited all these exhibitions a steady and marked improvement in the style and class of work is distinctly noticeable. Photographs have been sent in from all parts of the world, as many as four thousand pictures having been entered. A large number of money prizes, and gold, silver, and bronze medals, have been awarded, and the work is so excellent that in many cases the judges—Captain W. de W. Abney, Mr. T. C. Hepworth, the editor of the *Camera*, Mr. Hastings, and Mr. Duncuft—must have had great difficulty in finally deciding to whom the palm should be awarded. It is very noticeable, also, that both ladies and gentlemen seem to acquire the art of photography with great ease, and gain proficiency with wonderful rapidity; some who have now taken gold medals were, only two years ago, perfectly ignorant of the art. The exhibits now on view number 2,260 mounts, the majority of which are shown in portfolios, while a large number of the prize pictures have been framed and hung upon the walls. These illustrate an immense variety of the branches of photographic art-portraiture, landscape, architecture, warfare, animal studies, genre pictures, instantaneous views of action, micro-photography and other branches being well represented.

Taking the exhibits in their order in the catalogue, we see at Frame 1 Mrs. Edward Penton's highly commended and highly commendable views of Tintern Abbey. Frames 2 and 3 contain Mr. Harry Tolley's exquisite pictures, "White-robed Nature," a delicate snow scene, and "At Ilam, Derbyshire," to which have been awarded the 10*l.* prize given in Class I., which was open to all amateurs, and the gold medal given by the *Camera Magazine* for the best general work. Mr. Tolley also exhibits, Nos. 49, 50, 57, a beautiful platinotype of a group in a boat gathering water-lilies, and 75, a very fine interior of Exeter Cathedral. In Class II., for marine subjects, the silver medal has been carried off by Captain C. M. Harrison for his excellent pictures of yachts in motion, Frame 5. In Class III., for sporting pictures, the 5*l.* prize has been taken by Lieutenant R. B. Croft, R.N., for Frame 15, which contains seven studies of animals. The silver medal has been taken by Mr. J. T. Hopwood for his beautiful little Jersey cattle (69), while one of the bronze medals has fallen to Sir M. G. and Miss F. Harvey for their pictures of "Sport in Many Lands," two of which appear in Frame 41, and represent a dead hippopotamus and a dead buffalo, each being surrounded by a group of beaters and sportsmen. In Class IV., for the most original picture, the silver medal has deservedly fallen to the Rev. F. C. Lambert for Frame 52, which contains three pictures, viz., "The Jubilee Joke," the cleverest study of laughter that we have ever seen; "There is No Deception; the Amateur Conjuror," a capital interior and composition picture; and "The Amateur Photographer," a little girl pretending to take the portrait of another little girl and a baby by means of a camera made of an old chimney-pot hat. The bronze medals have been awarded to the Countess Oriola (45). Two pictures, called "At the Fountain"—after the Greek style—and "A Family Group" of Egyptian women and child, which is far the best of the three; and to Dr. E. W. Alabone (16) for his exceedingly comic pictures—"Going," "High Jump," and "Gone." In Class V., open only to pupils of the Stereoscopic Company, the gold medal was awarded to Mr. Howard J. Kennard for Frames 11 and 12, exquisite views of the Rhine and Switzerland; the silver medal to Mr. J. T. Hopwood for (73) "Winter" and a splendid interior, the "Music Room, Ribton Hall." In this class six medals were awarded, and the work is of the highest excellence. In Class VI., which is open only to those who have begun the art with the present year, some really remarkable work is shown. The 5*l.* prize was well won by Mr. E. A. Golledge for Frame 60, which contains eight pictures, of which the most interesting are the instantaneous views (1) of "Ladies Bathing" (284) of "Yachts in Motion," and (8) of "Yarmouth Bridge." No. 5, of children "Going for a Drive" in a goat chaise, is quite charming. Four other awards were made in this class, the silver medal being given to Mr. D. A. Clarke, M.A., for Frame 24, which contains three excellent pictures, of which the best is "Filling the Water-cart." In Class VII., open only to the fair sex, awards have been made to five ladies, Miss C. Wrigley being the winner of the 5*l.* prize for Frame 61, which contains four country pictures, of which the prettiest is another "Gathering Lilies"—a man standing in a punt on a beautiful piece of water. In Class VIII., open only to customers of the company, the 10*l.* prize has been won by Mr. G. Davison, for a set of three capital pictures (78); and ten awards have been given, one bronze medal having fallen to the Rev. H. B. Hare, whose excellent work last year makes us wish he had been more strongly represented this time. In Class IX., for officers of her Majesty's service, six awards were made, Surgeon F. M. Puddicombe, R.N., winning the silver medal for Frame 8, which contains four most interesting pictures, of which (1) "A Torpedo Boat going 16 knots an hour," and (3) "Whitehead Torpedo in the act of Explosion," are the most noteworthy. Mr. Cyril S. Cobb is the winner of the silver medal in Class X., and Lieutenant G. H. Call in Class XI. for (70), of which two views of the interior of the White Marble Palace at Delhi are very beautiful. In Class XII., open to members of the learned professions, Mr. W. Lant

Carpenter wins the silver medal for his ten photographs from fossils (81), and Mr. S. F. Clarke a bronze medal for his twenty-two wonderful micro-photographs (72). In Class XIII., for photographs taken on the company's dry-plates, Mr. Carpenter again wins a silver medal for (20) eight beautiful views, and Miss E. G. Stone a bronze medal for Frame 71, which contains five pictures, of which the best are "The Sunflower"—a beautiful little girl holding the flower in question—and "Sisters"; another bronze medal was won by Mr. A. J. Baines. The gold medal in Class XIV., for large direct photographs, was won by Mr. J. T. Hopwood for Frame 56, which contains six pictures, of which the most noticeable is "Jack," a pretty boy in sailor's dress dancing a hornpipe; while Mr. William Adcock carries off the silver medal for (54) "A Labourer's Luxury," a good rugged face with a pipe in its mouth. The two bronze medals in this class were awarded respectively to Messrs. H. Mansfield and J. E. Dumont. Mr. Dumont's (10) "His Own Barber" being exceedingly clever and amusing. The silver medal given by the *Amateur Photographer* for artistic treatment of difficult subjects is awarded to Mr. G. Davison, for "A Breezy Day in Spring" (78), and the bronze medal to Miss Miles for her studies of horses (80).

A pleasant hour or two can be spent in inspecting this exhibition, which will remain open until further notice, and which can be viewed gratis on presentation of a visiting card. Such a visit will give a very adequate notion of recent advances in photography, and is likely to encourage the visitor who is not already a photographer to endeavour speedily to acquire this charming and useful art.

DARWIN'S LIFE AND LETTERS.

I.

THESE long-expected volumes justify the eagerness with which they have been awaited. In these days, when biographical body-snatchers pounce on their victims before, as the phrase goes, the grave is cold over them, Mr. Francis Darwin reproves our haste and justifies his delay in allowing more than five years to pass before issuing this work, while he shows himself of like spirit with his illustrious father, the note of whose life is that he possessed his soul in patience. The book is executed with consummate skill and reverent care. The biographer is in no wise obtrusive; he comes between reader and subject only to supply the needed links to connect the letters which comprise four-fifths of the work, adding a sketch of his father's everyday life and methods of working, not gratifying overmuch the idle curiosity which hungers for gossip about the private life of celebrities, but just putting us on easy terms with Darwin, so that we feel we know what manner of man he was, and find every favourable impression given us by his books and his relations with his contemporaries confirmed. Looming larger than he himself dreamed among the makers of epochs, he did not strive nor cry, but kept himself from the clamour of tongues in the quiet sanctuary of home, partly because he preferred the seclusion, but also because the nature of his work demanded it, and chiefly because of the wretched health which, especially after his voyage, prostrated him for weeks together, and even under the best conditions permitted him to work but three hours a day. For these reasons only a favoured few were received into the family circle at Down, and the society even of these was rarely sought "because of the excitement, violent shivering, and vomiting thus brought on."

We quote from the chapter in the first volume, to which readers will turn with most interest, as containing the modest and candid autobiography which, without any thought that it would ever be published, Darwin wrote for his children when in his sixty-seventh year, "as if," he says at the outset, "I were a dead man in another world looking back at my own life." Next in interest to this is a characteristic paper by that "defender of the faith," Professor Huxley, who narrates, for the advantage of a generation which has grown up since the battle raged, the story of the reception of the "Origin of Species." Upon the preparation of this and Darwin's succeeding books the letters throw abundant light, and for this purpose Mr. Francis Darwin has wisely arranged them according to their several subjects. By far the larger number are addressed to Sir Joseph Hooker, whose fortunate prescience has preserved them from the commencement; and next in importance are those addressed to the late Sir Charles Lyell and to Professor Huxley. Both in the nature of its contents and in the simple, lovable, truth-seeking character which it exhibits, as of one to whom affection was dearer than fame, a more delightful and abidingly valuable collection has never been made public.

Darwin came of a long line of Lincolnshire yeomen, whose forbears spelt the name variously, as Darwen, Derwent, Darwynne, perhaps deriving it from rivers of kindred name. His father was a kindly, prosperous Shrewsbury doctor, son of Erasmus Darwin, also a doctor, and the celebrated author of "Zoonomia," the "Botanic Garden," and other florid and fantastic productions, in which, however, an accurate scientific presentment of certain facts of development is embodied. Beyond reminding our readers that his famous grandson was born at Shrewsbury in February 1809, educated at the Grammar School there, then at Edinburgh and Cambridge Universities; occupied as volunteer naturalist on board the *Beagle* from December 1831 till October 1836; that he published the "Origin of Species" in 1859, and was laid to rest in April 1882 near the grave of Newton in our beautiful Abbey of Westminster, we shall skip further oft-told detail, and, for the benefit of those to whom these portly volumes, the price of which is six-and-thirty shillings, may not be within reach, deal with some of the fresh matter which they contain, and the authority for which is mainly vouched for in Darwin's own words.

As with not a few other men of light and leading, neither school nor university did much for him, nor did his boyhood give indication of future greatness. In his answers to the series of questions addressed to various scientific men in 1873 by his cousin, Francis Galton, he says: "I consider that all I have learnt of any value has been self-taught," and he adds that his education fostered no methods of observation or reasoning. Of the Shrewsbury Grammar School, where, after the death of his mother in his ninth year, he was placed as a boarder till he was sixteen years old, he tells us "nothing could have been worse for the development of my mind;" all that he was taught were the classics, and a little ancient geography and history—no mathematics, and no modern languages. And this is the abortion which still does duty for "education" in five-sixths of the schools of England, where the mechanical curriculum has no relation to the duties of after life. Happily for Darwin, he had inherited a taste for natural history and for collecting, his spoils including not only shells and plants, but also coins and seals. When the fact that he helped his brother in chemical experiments became known to Dr. Butler, that desiccated pedagogue publicly rebuked him "for wasting time on such useless subjects." His father, angry at finding that he was doing no good at school,

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reproved him for caring for nothing but shooting, dogs, and rat-catching, and declared that he would be a disgrace to the family! He sent him to Edinburgh University with his brother to study medicine, but Darwin found the dulness of the lectures intolerable, and the sight of blood sickened him, as it did his father. Although the effect of the "incredibly" dry lectures on geology made him—the future Secretary of the Geological Society!—vow never to read a book on the science, or in any way study it, his interest in biological subjects grew, and its firstfruits were shown in a paper read before the Plinian Society at Edinburgh in 1826, in which he reported his discovery that the so-called ova of *Flustra*, or the sea-mat, were larvæ.

But his father had to accept the fact that Darwin disliked the idea of being a doctor, and fearing that he would degenerate into an idle sporting man, proposed that he should become a clergyman! Darwin says upon this:—

I asked for some time to consider, as from what little I had heard or thought on the subject I had scruples about declaring my belief in all the dogmas of the Church of England, though otherwise I liked the thought of being a country clergyman. Accordingly I read with care "Pearson on the Creed," and a few other books on divinity; and, as I did not then in the least doubt the strict and literal truth of every word in the Bible, I soon persuaded myself that our creed must be fully accepted. Considering how fiercely I have been attacked by the orthodox, it seems ludicrous that I once intended to be a clergyman. Nor was this intention and my father's wish ever formally given up, but died a natural death when, on leaving Cambridge, I joined the *Beagle* as naturalist. If the phrenologists are to be trusted, I was well fitted in one respect to be a clergyman. A few years ago the secretaries of a German psychological society asked me earnestly by letter for a photograph of myself; and some time afterwards I received the proceedings of one of the meetings, in which it seemed that the shape of my head had been the subject of a public discussion, and one of the speakers declared that I had the bump of reverence developed enough for ten priests.

The result was that early in 1828 he went to Cambridge, the three years spent at which were "time wasted, as far as the academical studies were concerned." His passion for shooting and hunting led him into a sporting, card-playing, drinking company, but science was his redemption. No pursuit gave him so much pleasure as collecting beetles, of his zeal in which the following is an example: "One day, on tearing off some old bark, I saw two rare beetles, and seized one in each hand; then I saw a third and new kind, which I could not bear to lose, so I popped the one which I held in my right hand into my mouth. Alas! it ejected some intensely acrid fluid, which burnt my tongue so that I was forced to spit the beetle out, which was lost, as was the third one."

Darwin scarcely does his *Alma Mater* justice, for, happily for his future career, and therefore for the interests of science, he became intimate with men like Whewell, Henslow, and Sedgwick, while the reading of Humboldt's "Personal Narrative," and of Sir John Herschel's "Introduction to Natural Philosophy," stirred up in him "a burning zeal to add even the most humble contribution to the noble structure of Natural Science." The vow to eschew geology was quickly broken when he came under the spell of Sedgwick's influence, but it was the friendship of Henslow that determined his after career, and prevented him from becoming the "Rev. Charles Darwin." For on his return from a geological tour in Wales with Sedgwick he found a letter from Henslow awaiting him, the purport of which is in the following extract:—

"I have been asked by Peacock (Lowndean Professor of Astronomy at Cambridge) to recommend him a naturalist as companion to Captain Fitz-Roy, employed by Government to survey the southern extremity of America. I have stated that I consider you to be the best-qualified person I know of who is likely to undertake such a situation."

In connection with this the following memorandum from Darwin's pocket-book of 1831 is of interest:—"Returned to Shrewsbury at end of August. Refused offer of voyage."

This refusal was given at the instance of his father, who objected to the scheme as "wild and unsettling, and as disreputable to his character as a clergyman"; but he soon yielded on the advice of his brother-in-law, Josiah Wedgwood, and on Darwin's plea that he "should be deuced clever to spend more than his allowance whilst on board the *Beagle*." On this his father answered with a smile, "But they tell me you are very clever." It is amusing to find that Darwin narrowly escaped being rejected by Fitz-Roy, who, as a disciple of Lavater, doubted whether a man with such a nose as Darwin's "could possess sufficient energy and determination for the voyage."

With the details of that voyage, the one memorable event in Darwin's otherwise unadventurous life, our readers are surely familiar, for they are set down in delightful narrative in his "Naturalist's Voyage Round the World," and it will suffice to quote a passage from the autobiography bearing on the significance of the materials collected during his five years' absence.

During the voyage of the *Beagle* I had been deeply impressed by discovering in the Pampean formation great fossil animals covered with armour like that on the existing armadillos; secondly, by the manner in which closely allied animals replace one another in proceeding southwards over the continent; and thirdly, by the South American character of most of the productions of the Galapagos Archipelago, and more especially by the manner in which they differ slightly on each island of the group, none of the islands appearing to be very ancient in a geological sense. It was evident that such facts as these, as well as many others, could only be explained on the supposition that species gradually became modified; and the subject haunted me. But it was equally evident that "none of the evolutionary theories then current in the scientific world" could account for the innumerable cases in which organisms of every kind are beautifully adapted to their habits of life. . . . I had always been much struck by such adaptations, and until these could be explained, it seemed to me almost useless to endeavour to prove by indirect evidence that species have been modified. . . . In October 1838, that is, fifteen months after I had begun my systematic inquiry, I happened to read for amusement "Malthus on Population," and being well prepared to appreciate the struggle for existence which everywhere goes on, from long-continued observations of the habits of plants and animals, it at once struck me that under these circumstances favourable variations would tend to be preserved, and unfavourable ones destroyed. The result of this would be the formation of new species.

Shortly after his return he settled in London, prepared his journal and manuscripts of observations for publication, and opened, he says under date of July 1837, "my first note-book for facts in relation to the origin of species, about which I had long reflected, and never ceased working for the next twenty years." He acted for two years as one of the honorary secretaries of the Geological Society, which brought him into close relations with Lyell, and as his health allowed him to go into society he saw a good deal of prominent literary and scientific contemporaries, among these, Herschel, Carlyle, Macaulay, Buckle, and Sydney Smith. His reminiscences of these were evidently vague, of no one of them does he attempt any full-length portrait; clearly they were not in "touch" with him. He quotes an amusing story, which was told by Sydney Smith at Dean Milman's, of the penurious Lady Cork, who was once so much affected by one of the witty Canon's charity sermons that she *borrowed* a guinea from a friend to put in the plate. He has most to say about the fellow-dyspeptic who empties big buckets of contempt on a theory which he had never the patience to study, and who has only words of superior pity for the poor creatures who wade through the "Origin of Species," of which he says he could never read a line.

The last man whom I will mention is Carlyle, seen by me several times at my brother's house, and two or three times at my own

house. His talk was very racy and interesting, just like his writings, but he sometimes went on too long on the same subject. I remember a funny dinner at my brother's, where, amongst a few others, were Babbage and Lyell, both of whom liked to talk. Carlyle, however, silenced everyone by haranguing during the whole dinner on the advantages of silence. After dinner Babbage, in his grimmest manner, thanked Carlyle for his very interesting lecture on silence.

Carlyle sneered at almost everyone: one day in my house he called Grote's "History" a "fetid quagmire, with nothing spiritual about it." I always thought, until his "Reminiscences" appeared, that his sneers were partly jokes, but this now seems rather doubtful. His expression was that of a depressed, almost despondent, yet benevolent, man; and it is notorious how heartily he laughed. I believe that his benevolence was real, though stained by not a little jealousy. No one can doubt about his extraordinary power of drawing pictures of things and men—far more vivid, as it appears to me, than any drawn by Macaulay. Whether his pictures of men were true ones is another question.

He has been all-powerful in impressing some grand moral truths on the minds of men. On the other hand, his views about slavery were revolting. In his eyes might was right. His mind seemed to me a very narrow one; even if all branches of science, which he despised, are excluded. It is astonishing to me that Kingsley should have spoken of him as a man well fitted to advance science. He laughed to scorn the idea that a mathematician, such as Whewell, could judge, as I maintained he could, of Goethe's views on light. He thought it a most ridiculous thing that anyone should care whether a glacier moved a little quicker or a little slower, or moved at all. As far as I could judge, I never met a man with a mind so ill-adapted for scientific research.

In the autumn of 1842, two years and eight months after his marriage with his first cousin, Emma Wedgwood, Darwin removed from London, the air and social demands of which were alike unsuited to his health, and finally fixed upon a house in the secluded village of Down, near Beckenham, where he spent the rest of his days. Henceforth the life of Darwin is merged in the books in which, from time to time, he gave the result of his long years of patient observation and inquiry, from the epoch-making "Origin" to the monograph on earthworms. With bad health, apparently due to gouty tendencies aggravated by chronic sea-sickness during his voyage; with nights that never gave unbroken sleep, and days that were never passed without prostrating pain, he might well have felt justified in doing nothing whatever. But he was saved from the accursed monotony of a wealthy invalid's life by his insatiate delight in searching for that solution of the problem of the mutability of species which time would not fail to bring. In this, he tells us, he forgot his "daily discomfort," and thus was delivered from morbid introspection.

Before dealing with the circumstances which hastened the publication of the "Origin of Species," and with the influence of that book on belief in the supernatural, we may briefly describe some aspects of the man himself, as presented in Mr. Francis Darwin's chapter on the family life at Down.

The dome-like forehead with thick bushy eyebrows, the Socrates-like features, the figure wrapped in loose cloak, with broad-brimmed felt hat in hand, are familiar to us through photographs. But these do not tell us that he was six feet in height, of stooping posture, with eyes bluish-grey, and ruddy complexion which gave no sign of the discomfort from which he was never wholly free. His laugh had an honest and sounding ring, he overflowed with geniality that no pain could unsweeten, he was a devoted father—the touching record of the little maiden whom he lost, and on whose tomb he inscribed the simple words, "A dear, good child," evidence the tenderness of the man—he was fond of animals, courteous even to the more inferior species, known as bores; careful in money matters, extending this to the small concerns of the village Friendly Club; he betrayed an anxiety, strange in a man of his wealth, about leaving his children a competency; there was a curious side of penuriousness in his economy of paper, from the backs of old MSS. to the fragments of spills. He took snuff when he worked, and smoked when he rested, glad, after the more serious tasks and correspondence of the day were over, to listen to novels, for which he had a great love so long as they ended happily and contained "some person whom one can thoroughly love, if a pretty woman, so much the better." Strangely enough, he lost all pleasure in music, art, and poetry after thirty. When at school he enjoyed Thomson, Byron, and Scott; Shelley gave him intense delight, and he was fond of Shakespeare, especially the historical plays; but in his old age he found him "so intolerably dull that it nauseated me."

This curious and lamentable loss of the higher æsthetic tastes is all the odder, as books on history, biographies, and travels (independently of any scientific facts which they may contain), and essays on all sorts of subjects, interest me as much as ever they did. My mind seems to have become a kind of machine for grinding general laws out of large collections of facts, but why this should have caused the atrophy of that part of the brain alone on which the higher tastes depend I cannot conceive. A man with a mind more highly organised or better constituted than mine would not, I suppose, have thus suffered; and, if I had to live my life again, I would have made a rule to read some poetry and listen to some music at least once every week, for perhaps the parts of my brain now atrophied would thus have been kept active through use. The loss of these tastes is a loss of happiness, and may possibly be injurious to the intellect, and more probably to the moral character, by enfeebling the emotional part of our nature.

TRICK WITH PAPER RINGS.

THE annexed engraving from *La Nature* shows the method of preparing paper rings for the performance of a curious experiment. Take three strips of paper, 2 inches in width by from 2 to 5 feet in length, and with

one of them form a ring, as shown in fig. 1, by pasting the two ends together. Before pasting the ends of the

second ring, give the paper a single twist (fig. 2), and before completing the third ring give the strip two twists. These twists in the completed rings (1 and 2) will be so much the less perceptible in proportion as their diameter is greater.

If we take a pair of scissors and cut through the circumference of ring No. 1 in the direction shown by the dotted lines, we shall obtain two rings, as shown in No. 1′. Proceeding in the same way with ring No. 2, we shall obtain a single elongated ring, as shown in No. 2′, and with No. 3, two rings which are connected like the links of a chain, as shown in No. 3′.

Reviews.

Factors in Life. By H. G. SEELEY, F.R.S. (Society for Promoting Christian Knowledge.)—This work consists of three lectures upon the important subjects of health, food, and education. We have no hesitation in saying that it is a book that will do good wherever it is read. The thoughtful will find matter for more thought, and those who do not habitually think on these essential matters may, and probably will, find facts so strikingly placed before them as to impress them to their advantage. The language is rather above our artisans, but we should like to see it in their hands. It would make an excellent reader, for instance, in the higher classes in Board schools, or a capital little volume for cheap school prizes.

Manual of Zoology. By H. ALLEYNE NICHOLSON. (Wm. Blackwood & Sons.)—This book carries its own credentials in the imprint "seventh edition" on its title-page. But it is an edition which, keeping in step with the quick march of biological science, has been re-cast and re-written, so that it claims to be regarded as essentially a new work, and in comparing it with its immediate predecessors we find this claim warranted. The author's leanings to some fundamental difference between the inorganic and the organic are still apparent; but his treatment of the question is eminently fair, and his observations on the vulnerable part of the theory of natural selection have a force which Darwin himself never underrated, and which gives Professor Nicholson occasion to refer to Mr. Romanes's moribund theory of physiological selection. The *exposé* of the Duke of Argyll's baseless charge of *suppressio veri* against biologists in the matter of Mr. Murray's revision of Darwin's theory of the formation of coral reefs, which Professor Huxley gives in the November number of the *Nineteenth Century*, has further illustration in Professor Nicholson's reference. We observe that, in accordance with the best authorities, the author removes the sponges from the lowest sub-kingdom and promotes them to a sub-kingdom between the Protozoa and Cœlenterata, called the Porifera. We hope that the sponges duly appreciate this recognition of their nearer kinship with man. Altogether, the volume is to be accorded high rank as a complete and accurate, yet, having regard to its subject, not unwieldy, text-book. It is profusely illustrated with excellent woodcuts.

Sketch of Geological History. By EDWARD HULL, F.R.S. (C. W. Deacon & Co.)—The Director-General of the Geological Survey of Ireland follows illustrious examples in preparing this abstract of a science which he has at his fingers' ends. But, except as rounding off the series of historical manuals which the same publishers have issued, we fail to see the general object of the book. It is an attempt to compress a vast subject into an absurdly small space, with the result that the book reads like an enlarged index, which may be found useful to readers intending to pursue the subject farther. Dr. Hull has certainly no breath of genius in his style, whereby these dry bones might live, while, as in no wise strengthening his authority, he inclines to some modified theory of special creations, which may partly account for his reference to the appearance of marsupials as "born out of due time." The truer explanation seems to be that these highly organised forms existed at far more remote epochs than their earliest-known remains indicate.

The Tshi-speaking Peoples of the Gold Coast. By Major A. B. ELLIS. (Chapman & Hall.)—The whole of the forest tract lying between the Assini and Volta rivers on the Gold Coast is inhabited by negro tribes speaking dialects of one language, called the Tshi (pronounced Tchwi). The enfeebling climate is largely responsible for their generally low condition, sufficing evidence of its deadening effect on both mind and body being cited by Major Ellis in the relapse of the inhabitants of Liberia, who are the descendants of freed American negroes, into barbarism. But although the tribes whose beliefs and customs are vividly and skilfully described have, except where in contact with the European settlers on the coast, and then only slightly, not been affected by foreign intercourse, their social organisations show them to be far above the savage level. It is in their customs, made tyrannically binding by connections with duties to the several orders of gods—tribal, local, family, and individual or tutelary—and in their crude ideas of death as unnatural, of the reality of dreams, of the ascription of life to every moving thing, and so forth, that the proofs of their unprogressiveness are found, and it is the details concerning these which make Major Ellis's book one of great value to the anthropologist, while it abounds in interesting matter for the non-specialist. Although the author explains totemism on Mr. Herbert Spencer's theory that an ancestor was once called by the name of an animal or plant, and that in the course of time his descendants, ignorant of the origin of a name, came to believe that he was descended from one or the other, and therefore abstained from them as food; and although he appears to accept Mr. Max Müller's explanations of fetichism as the corruption of a primitive faculty whereby man apprehends God, we find his information valuable and trustworthy, because he sees the difficulty of getting at facts free from the distorting media, fond delusions, and preconceptions of many travellers. It is a great gain to have such a book from so acute and dispassionate an observer as Major Ellis, and we hope that the reception which will be accorded to it may stimulate him to continue this important work of adding to our stock of knowledge concerning the ideas and practices of races whose extinction is only a question of time.

Animals from the Life. By HEINRICH LEUTEMANN. Edited by ARABELLA B. BUCKLEY. (Edward Stanford.)—We must accord this charming and delightful book the first place among worthy gifts for our young folk this season. Miss Buckley has adapted the German original—the distinctive and careful feature of which is in its actual studies from the life—to the requirements of English children, for whom she describes, in her own accurate and easy style, the animals grouped on each plate. They are given in descending scale, from man to sponge, and dull must the child be in whom these beautifully-coloured pictures do not awaken interest in all that lives.

From a Garret. By MAY KENDALL. (Longmans.)—"That Very Mab" gave ample proof of Miss Kendall's cultivated intellectual gifts, and "that very" clever book led us to expect some less fugitive work from her brilliant, and often caustic, pen than the present collection of studies. The device of a prologue, which purports to edit somebody else's manuscript, is a trifle stale, and neither awakens nor enhances interest in characters that play a more or less real

part in these slight sketches. Most vivid among these are the tramcar man, who could only get time to be married before the registrar while the horses were being changed; most touching the story of Sally, the lodging-house slavey. Some of the others, as the chemist and the bumptious mathematical girl, are but lay figures upon which the remnants of barren controversies are hung. No one who begins the book will lay it down until the epilogue is reached; but Miss Kendall should send out no more scouts and stragglers, and prove herself as capable as we believe her to be of a sustained and serious effort.

We say this the more emphatically after reading her dainty little volume of poems, *Dreams to Sell* (same publishers), which her friend "A. L." introduces in charming stanzas as songs that "please him well." They are worthy of the praise of so accomplished a critic and poet; delightful is the echo of Matthew Arnold's "Forsaken Merman," which "The Mermaid's Chapel" awakens; and the "Ballad of the Cadger" will be welcome to the lovers of Austin Dobson's "Child Musician." But Miss Kendall must get her evolutionary lays revised by experts, who will correct her removal of Trilobites from the Crustacea to the Arachnida, and of the Monotremes from pond and marshy burrows to the "silent sea."

Health Maps. By ANNA T. ARNIM. (Swan Sonnenschein.)—This work is issued in five neat and portable parts or "groups," each being prefaced with a clear and crisp introduction, and filled with a distinct set of exercises adapted to stimulate and strengthen a given set of muscles. Each exercise is illustrated by a diagram, a description of the particular movement, and a note specifying in which muscles of the body the movements should be felt. The "groups" form a complete manual of instruction by which even unskilled teachers may quickly train themselves to give many of the lessons.

Equally worthy of commendation as well adapted for its purpose, is *The Teacher's Manual of Drill*, by MARY E. HUDSON (Griffith, Farran, & Co.). The practical directions are given with admirable simplicity, and so varied as to cause the minimum of fatigue to children.

Handy Volume Atlas of the British Empire. (Geo. Philip & Son.)—This neat and compact little book is a companion volume to the publishers' "Handy Volume Atlas of the World." In the space of 6 by 3 inches there are packed 120 maps and plans of exquisite clearness, supplemented by an index of 10,000 place names, and interleaved with geographical and historical notes. It is a marvel of excellence in rare combination with cheapness, for the published price is only 3s. 6d.

Posthumous Humanity. By ADOLPHE D'ASSIER. Translated and Annotated by HENRY S. OLCOTT. (London: George Redway. 1887.)—There is something particularly sad in the history of this collection of hopeless trash. Blind and partly paralysed, its unfortunate author has listened to and gravely recorded as fact a series of the veriest "cock and bull" stories it was ever our misfortune to be compelled to wade through. His book is a mere *réchauffé* of second, third, fourth, and so on to *n*th, hand legends, many of them mediæval, and the vast majority, in popular parlance, "as old as the hills." Haunted houses, witchcraft, wehrwolves, lycanthropy, vampires, and so on, and so forth, are all accepted by poor M. d'Assier as being as undeniable as sun-rise. If these lines were ever likely to be read to him in the only language which he apparently understands, we would urge him to read the account of the "Stockwell Ghost," in vol. i. of Hone's "Everyday Book," whence he would learn how missiles were thrown, cups, plates, and saucers dashed about, a pail of water set boiling, &c., in broad daylight in the presence of scores of people, and how the maid-servant, Ann Robinson, subsequently confessed in detail how she herself performed every one of these miracles. He might, perchance, detect the intimate resemblance of the Stockwell phenomena to those which he himself narrates. Colonel Olcott's notes are beneath contempt. Two illustrations of this must suffice. On page xv. of the Introduction he quotes Professor Hare as having verified "the reality of mediumistic phenomena," studiously suppressing the fact that Mr. Hare was insane—in fact, died in a lunatic asylum. Again, on page 180, he speaks of Mr. Crooke photographing materialised spirits "by the electric light in his own laboratory," as studiously concealing the fact that the "spirit" thus photographed was Miss Florrie Cook, subsequently detected, *flagrante delicto*, and exposed, by Sir George Sitwell and Herr von Buch. Sometimes, though, the author is too credulous even for Mr. Olcott, *vide* footnotes on pages 121, 197, &c. A more piteous literary exhibition than the entire volume has rarely come under our notice. There is not one scrap or atom of evidence in it on which any magistrate would dare to send the veriest tramp to gaol for a week's hard labour.

Claverhouse. By MOWBRAY MORRIS. (London: Longmans, Green, & Co. 1887.)—Here is another attempt to rehabilitate a man to whom history—or rather, perhaps, tradition—has not been too kind; and, as it seems to us, in this case considerable success has attended the efforts of his latest biographer. Whatever virtues the Covenanters may have possessed, truthfulness in connection with those opposed to them was very far indeed from being one of the most conspicuous; and hence the legends of Claverhouse's ferocity which appear in the pages of chroniclers like Wodrow must be taken with a very large grain of salt indeed. It must be carefully borne in mind that "Bonnie Dundee" lived in an age which was essentially rough and brutal, when the refinements of modern warfare were unheard and undreamt of, and when, for example, anything like a joint undertaking on the part of nations to limit the size or description of their service projectiles would have been scouted as the wildest nonsense. When, then, Claverhouse was sent out to suppress what amounted to an open rebellion against his sovereign, he employed the tactics of his day, which were no more of the rose-water school than those of the insurgents themselves. That, however, he was the malignant, bloodthirsty scourge which the old Covenanters represented him to be, Mr. Mowbray Morris has clearly disproved in the very interesting and readable volume before us.

The Ambulance Pupil. By A PUPIL OF THE ST. JOHN AMBULANCE ASSOCIATION. (London: Crosby Lockwood & Co. 1887.)—This tiny pocket volume should be in the possession of everyone who is ever likely to be present at an accident, either to himself in person or to others; as the simple directions may, if followed out, be the means of saving many a precious life.

Specific Unbelief: England's Greatest Sin. By ANDREW SIMON LAMB. (London: James Nisbet & Co. 1887.)—It is much to be desired that Mr. Lamb should read, mark, learn, and inwardly digest the whole of the third part of "The Problem of Evil," by Daniel Greenleaf Thompson. He simply reiterates what may be heard next Sunday in any "Little Bethel" in the kingdom, being obviously an "Evangelical" of the narrowest type. We should be curious to know how he would attempt to connect the deaths of the flint-folk, who lived and died 20, 50, or even 100,000 years ago, in their caves, with the transgression of the "first man," Adam. Had Mr. Chadband been rather better educated, he might well have written this little book.

XUM

VENUS AS A MORNING STAR.

It seems impossible to imagine that the numerous correspondents who have descended upon us with a flood of more or less nonsensical questions about "The Star of Bethlehem" can ever look at the column headed "The Face of the Sky," which appears in every monthly part of this magazine. Reference to that column for November and December will show that its writer specifically speaks of Venus as "a brilliant object to the south of east about 3 A.M.," and as "a most brilliant and conspicuous object in the south-east before sunrise"; but, ignoring this, a number of persons who are, or profess to be, readers of KNOWLEDGE, have inundated us with queries as to whether a new variable or periodical star has become visible? whether the Star of Bethlehem has reappeared? whether it is the one that appeared to the Wise Men?—(in which category this particular querist as modestly as properly omits to include himself)—whether the original apparition (Matthew ii. 2, 9, and 10) was miraculous or not? and so on. Once for all, then, the star which has recently shone so gloriously in the morning sky is Venus, and nothing else in the world. She goes round the sun inside of the earth's orbit in about 224¾ days, and if the earth were stationary would, at the end of that period, come approximately into the same position in our (then) fixed sky. But, as every one knows, the earth herself revolves round the sun in something like 365¼ days, and hence Venus does not return to the same phase until after a lapse of 584 days—*i.e.* in one year, seven months, and about a week. Hence it will be seen that what we have been viewing is simply a recurrence of what happened during the early mornings in December 1885 and January 1886. Venus is now travelling away from the earth, and on July 11 will be behind the sun. Pursuing her path, she will emerge from his rays and reappear to the east of him, after which she will become an evening star, and in February and March 1889 will be as striking an object after sunset as she recently has been before sunrise. About Lady Day in that year she will be distinctly visible to the naked eye (of any one who knows precisely where to look for her) in bright sunshine. The Star of Bethlehem of Matthew's gospel—if it ever really existed and is not the mere embodiment of a myth—must in all probability have been a comet.

THE FACE OF THE SKY FOR JANUARY 1888.

THE sun presents but few features of interest for observers under existing circumstances, although one fine group of spots appeared last month upon his disc. The night sky is delineated on map i. of "The Stars in their Seasons." Minima of Algol ("The Stars in their Seasons," map xii.) will occur on Jan. 3 at 6h. 55m. P.M.; on the 20th, at 11h. 48m. P.M.; on the 23rd, at 8h. 37m. P.M.; and on the 26th, at 5h. 26m. P.M., as well as on other occasions inconvenient to the amateur observer. Mercury is a morning star up to the 14th, but subsequently souths after the sun. His great south declination, however, renders him practically invisible throughout the month. Venus is a morning star throughout January, and is very nearly as badly placed for the observer as Mercury. Mars does not rise until after midnight at the beginning of the year, and a little before 11h. 30m. P.M. by January 31. Moreover, he only looks like a large red star, and detail on his surface is quite beyond the power of ordinary telescopes. Jupiter is a morning star, and very badly placed to boot. In fact, Saturn is now the only striking object in the night sky. Starting from a point almost on a line joining γ and θ Cancri ("The Stars in their Seasons," map iii.), he will travel in a westerly and northerly direction. The closing up of his ring system since his opposition in 1885-86 is now very perceptible. Titan, his brightest satellite, will be at its greatest elongation east of him (between 11 and 12 diameters of the planet) at 3h. A.M. on Jan. 12; and at midnight on the 27th. Uranus is, for our present purpose, invisible, and Neptune is very much where we left him last month. The moon enters her last quarter at 11h. 42·6m. A.M. on the 6th, is new at 8h. 38·7m. on the morning of the 13th, enters her first quarter at 4h. 49·3m. A.M. on the 21st, and is full at 11h. 18·9m. on the night of the 28th. There will be a total eclipse of the moon on this night (that of the 28th), visible in this country, the leading details of which we subjoin in a tabular form:—

	H.	M.		
First contact with the penumbra	8	29·0	P.M.	Greenwich mean time.
First contact with the shadow	9	30·5	„	
Beginning of total phase	10	31·1	„	
Middle of the eclipse	11	20·1	„	
End of total phase	12	9·1	„	
Last contact with the shadow	1	9·7	A.M.	
Last contact with the penumbra	2	11·2	„	

If we call the moon's diameter 1, she will be immersed 1·643 of that diameter in the earth's shadow at the time of the middle of the eclipse. Measuring from the northernmost point of the moon's limb towards the east, the first contact with the shadow will take place 93° from such north point, and the last contact at 74° towards the west. This is as seen with the naked eye, not as viewed in an inverting telescope. Only three occultations of fixed stars by the moon will happen this month at all at convenient hours. The first happens on the 25th, when χ^3 Orionis, a star of the 6th magnitude, will disappear at the moon's dark limb, at 36 minutes after midnight, at an angle from her vertex of 178°, reappearing at 1h. 20m. the next morning at a vertical angle of 258°. Then, on the 29th, 7 Leonis, a 6¼ magnitude star, will disappear at the moon's bright limb, at 5h. 41m. P.M., at an angle of 332° from her vertex, and reappear at her dark limb at 5h. 55m. P.M. at an angle from her vertex of 298°. And, lastly, on the same evening ψ Leonis, of the 6th magnitude, will disappear at the bright limb of the moon, at 9h. 13m., at a vertical angle of 320°, reappearing at her dark limb, at 9h. 24m. P.M., at an angle of 300° from her vertex. These last two reappearances will happen very near to the illuminated part of the moon. The beginning of the new year finds the moon in Cancer, which, at 5h. A.M. on January 22, she quits for Leo ("The Seasons Pictured," plate xxiv.). She is travelling through Leo until 7h. P.M. on the 4th, at which hour she enters Virgo ("The Seasons Pictured," plate xxv.). Her journey through Virgo occupies her until 9h. 30m. P.M. on the 7th, and she then crosses the boundary into Libra ("The Seasons Pictured," plate xxvi.). As she travels over Libra, she arrives, at 2h. 30m. P.M. on the 9th, at the western edge of the narrow northern spike of Scorpio, and when 9 hours later she has traversed this, it is to emerge in Ophiuchus. At 1 P.M. on the 11th she leaves Ophiuchus and enters Sagittarius. Here she continues until 7h. 30m. P.M. on the 13th, then quitting Sagittarius for Capricornus ("The Seasons Pictured," plate xxi.). Her passage through Capricornus is completed at 7h. P.M. on the 15th, and she then passes into Aquarius. Here she remains until 10h. P.M. on the 17th, passing at that hour into Pisces ("The Seasons Pictured," plate xxii.). Journeying through Pisces, she, at 6h. P.M. on the 18th, arrives on the confines of Cetus, into which she plunges. From this she emerges at 1h. A.M. on the 20th, and re-enters Pisces; only, however, to pass for a second time into Cetus at 2h. A.M. on the 21st: when at 8 o'clock that night she finally leaves Cetus it is to pass into Aries ("The Seasons Pictured," plate xxiii.). She is travelling through Aries until 9h. P.M. on the 22nd, when she enters Taurus. In the course of her passage over Taurus she comes at 6h. 30m. P.M. on the 25th to the western edge of the most northern prolongation of Orion. This it takes her eleven hours and a half to cross, and when at 6 o'clock the next morning she has traversed it, she emerges in Gemini ("The Seasons Pictured," plate xxiv.). She leaves Gemini for Cancer at 1h. A.M. on the 28th, and Cancer, in turn for Leo, at 1h. P.M. on the 29th. She is still in Leo at midnight on the 31st.

A QUICK CALCULATOR.—Reuben Fields, a most extraordinary individual, has returned to his home in Kentucky, after an absence of some years in the West. Fields is known far and wide as the "Mathematical Prodigy," and, indeed, he is a wonderful creature. Perfectly illiterate, not being able to tell one letter or figure from another, he bears the same relation to the science of mathematics that Blind Tom does to music. Fields is now about twenty-eight years of age, and his ability to quickly and correctly solve the most difficult problems was discovered when he was eight years old. That faculty continued to develop until he is able to solve, with amazing rapidity, any problem in simple or compound fractions, or anything in the higher branches of mathematics. For instance, the moon is a certain number of miles from the earth; a grain of corn is so long; how many grains will it take to connect the points? The answer to this or any other problem comes like a flash. He can also tell to a second the time of day or night! This marvellous man has been tested by the most expert mathematicians, and his answers to problems have been found to be invariably correct. He claims that his power is a direct gift from the Creator, and liable to be taken away from him if not properly used. The possessor of this gift never went to school a day in his life, and never did a day's work, except to occasionally aid merchants in invoicing their goods, and in this business he has been known to keep a score or more of clerks busy footing up columns of figures. He is a very large man, and has a look the reverse of intelligent. Having no occupation, he lives among his acquaintances, putting up wherever night overtakes him. He is very proud of his gift, and frequently compares himself to Samson. Fields gave an exhibition of his powers before Governor Crittenden and other distinguished men of Missouri on a late visit West, and they consider him one of the greatest wonders of the century.

XUM

Our Whist Column.

By "FIVE OF CLUBS."

THE DOG AND THE SHADOW.

If you will not when you may,
When you will you shall have nay.—OLD PROVERB.

I WAS a looker-on, a few months ago (down in Florida), at a game of whist which illustrated charmingly the folly of the two commonest mistakes of the unscientific whist-player—(1) the idea that the fall of two trumps for one is bad for those who played them, where one of these has held a considerable strength; and (2) the notion that a ruff is always a gain for the ruffer.

I had been told to watch the play of an old gentleman whom we will call A (his partner being B); but I quickly found that his opponent on the left (Y), a comparatively young man, and a stranger to the rest of the company, was a much better player; while Z, the fourth player, though weak so far as original play was concerned, had none of that fatal cleverness which injures the game of those who trust wholly in their own ideas and will learn nothing from the stored experience of tens of thousands of players and a century and a half of play.

In the particular game which interested me most among those I watched, A had a long suit of diamonds, which he was lucky in seeing established in two rounds, leaving him four long diamonds, all small but all (as he perfectly well knew) as good as trumps (hearts) when trumps should be out. At the first opportunity A very properly led trumps (having four, headed by the king), and after three rounds, Z having had but one trump, A remained with king of trumps, B holding the queen, and Y a small one, obviously to all the table. Also, A held a small club, a suit of which his partner was void.

At this stage A had a choice between two good lines of play. His plainest course was to draw out the remaining trumps and make the four small diamonds; five tricks off the reel—which, with three made before, would give A-B two by tricks. The best course, however, was to force Y with a diamond, when, if Y yielded to the force, A could make his king trump by ruffing, then his three small diamonds, and finally give B a ruff, who might, as far as A could tell, be then able to make the last trick, in which case A-B would make three by tricks; and in any case A-B could not make fewer than two by tricks on this line as on the other. So that this was the correct play, though as the cards lay nothing would have been gained by it.

But the first of these courses was most objectionable to A, because it involved the fall of two trumps, and the two best trumps at that, for one of the enemy's. This was contrary to A's ideas of sound whist play, and his every word and gesture showed that he held himself the soundest player there. The other course was not less objectionable to him, for it would enable Y to make his little trump by ruffing one of A's winning diamonds.

Manifestly, A considered the proper thing to play for was to let B make his trump separately, then to capture Y's, make the long diamonds, and so secure three by cards. It did not occur to him that this, though a very proper thing to be done, if it *could* be done, was not at all the right thing to play for if it could not possibly be managed. If B were thus given the opportunity of making his trump queen, he could not possibly give A a lead whereby to extract Y's small trump. The only lead he could give A would be by forcing him, when Y would remain with the last trump and winning cards (as it happened) in clubs and spades, not one of A's established diamonds being of the least use to him. Thus two more tricks only would be made instead of five, and A-B would lose the odd trick instead of making two or three by tricks.

As a matter of fact, B did not ruff the card A had led to him for the purpose. Whether he had some half-formed notion that the only chance now left for A to get in his diamonds lay in B's passing this trick, on the chance that Y, who had taken it (bar the ruff), would lead a trump to draw two for one, was not clear. My notion is that B simply declined to ruff Y's winning club, a ten only, because he thought the queen of trumps too good a card to be used for that purpose, for most of B's play had been unutterably weak. Be this as it may, B passed the trick. Y immediately began to lead out winning spades, forcing A (for B had plenty of the suit). Then A, having nothing better to do, led a diamond, Y ruffed, B overruffed; and B having only spades to lead to Y's strength in the suit, Y made all the remaining tricks. Thus Y-Z made on this line the odd trick, as they would had B ruffed at the outset. This sequel strengthens the illustration which the game afforded of the folly of the doctrine that it must be good to draw two trumps from the enemy for one, and bad to draw two trumps from your own side for one from the enemy. For had Y played this game A would have made all his long diamonds, and A-B would have made two by tricks.

A immediately explained to B what his object had been, adding, "How unfortunately it turned out!" He should have said, "How ill I played!" Y simply scored the odd trick and smiled. He evidently felt it was no part of his business to teach his opponents better play.

DOUBLE DUMMY PLAY AND A DOUBLE DUMMY PROBLEM.

It has been said by Mr. F. H. Lewis, one of the finest whist-players living, and beyond all doubt the most skilful composer of double dummy problems, that double dummy is the grammar of whist. Players who doubt the value of accuracy in whist conversation should play double dummy awhile. It will give them entirely new ideas. Skill tells more in this game than in any form of whist, especially when played, as it certainly should be, without counting honours. (To my mind there is something absurd in counting honours, which depend solely on chance, at this purely scientific game.) In the long run, the best player invariably wins at double dummy; and in my own experience I have found that where there is any marked disparity of skill, every sitting of an hour or so leaves the better player ahead, the cards never running so strongly to one side as to let the weaker gain the majority of points. In my lecturing tour in the South in the season 1885-6, I lightened many hours of railway travelling by double dummy play with a friend (and relative) who travelled with me. He had had less practice in whist play than I, and had studied the language of the game much less (which is a very different matter, by the way). Now, though the cards would often run so heavily against me that I would lose ten or twelve points in the course of half an hour or so, every sitting ended by placing me further ahead, and when our travels ended I was 191 points to the good (we were "playing for love"). In actual whist this would not happen. It was easy to see how the effect of correct play came in. With good cards success was more complete; with bad cards failure was less disastrous. Five times I scored every trick (being twice able to announce from the beginning that this would be the result), and many times against apparently overwhelming hands I lost only the odd trick, or even made the trick. All this shows what may be done by the proper conduct of the game; and play, by which inferences as to the position of various cards may be early formed, enables watchful partners to do to some degree what the double dummy player can effect.

Next to actual double dummy play in value as whist practice comes the study of double dummy problems. Here is a problem by Mr. Lewis (it is taken from the "Westminster Papers," I need hardly say), which will be found worth careful study. It is not difficult—at least for those who have had practice in double dummy play. Solvers should keep their solution for comparison with the analysis, which will shortly appear, as it is impossible for me, living as I do in Florida, to examine the various solutions:—

THE HANDS.

B { H. (*trumps*).—A, Kn, 8, 6, 5. C.—A, K, Kn, 4.
S.—2. D.—A, 6, 4. }

Y { H. (*tps*).—Q, 10, 4.
S.—Q.
C.—Q, 10, 6, 5.
D.—Q, 9, 8, 7, 5. }

B
Y Z
Tr. Hearts
A leads.

Z { H. (*tps*).—K, 7, 2.
S.—K, 10, 9, 8, 7.
C.—9, 8, 7, 2.
D.—Kn. }

A { H. (*trumps*).—9, 3. C.—3.
S.—A, Kn, 6, 5, 4, 3. D.—K, 10, 3, 2. }

Hearts are trumps. A leads. How many tricks can A-B make against the best defence?

LOOSE MODEL BUILDING STONES, MANUFACTURED BY RICHTER & Co., and issued with books of instruction, showing how model arches, bridges, vaultwork, mosaic floors, and miniature houses can be constructed by very young people, may certainly be considered in the light of scientific toys of high order, and following, as they do, the form of ordinary bricks with decimal exactness, they afford opportunities of instruction to youthful minds in architecture and practical building. The fact of their being coloured tends to artistic training also. These stones or bricks can be advantageously adopted by the architect or builder for experimental purposes. We can, therefore, confidently recommend them to students of building and architecture, who would undoubtedly derive valuable assistance from them.

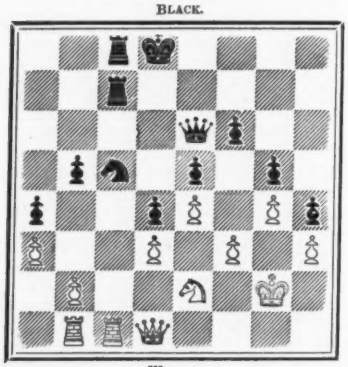
Our Chess Column.

BY "MEPHISTO."

THE TOURNAMENT OF THE B.C.A.

ENDINGS FROM ACTUAL PLAY.

BLACK.



WHITE.

THIS is a curious example of a block. Everything seems to be equal, but in reality White's pieces are all doomed to inactivity. Black forces a win by playing Kt to Kt6 at the right time, thereby compelling the exchange of Rooks, obtaining possession of the Bishop's file, and playing R to B7. White may vary his play, but he is unable to save the game.

1. R to B3.

What White actually did was to move his King backwards and forwards. Any other move would have likewise resulted as indicated above, for instance—2. Q to Q7, Kt to Kt6. (This is also the reply to R to B2.) 3. R × R, Q × R. 4. Q to Kt4 (to avoid Q to B7, and to obtain a perpetual check). 4. Q to B4. 5. K to B2, Q × Q. 6. P × Q, R to B7. 7. K to K sq., R to K7. 8. Kt to B sq., R to R7, and Black will win.

2. K to Kt sq.	2. R(B sq.) to B2
3. K to Kt2	3. Q to B sq.
4. K to Kt sq.	4. K to Q2.

Intended to meet a possible incursion of the Queen into Black's game.

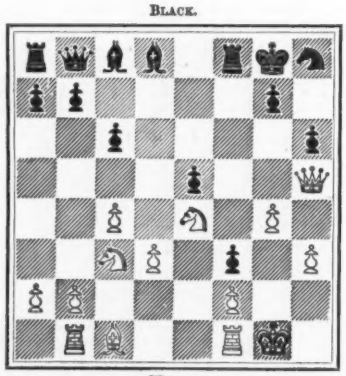
5. R to B2	5. Kt to Kt6

Of course Black would not at any time permit Kt to B sq.

6. R × R	6. R × R
7. Q to K sq	7. R to B7

and Black wins.

BLACK.



WHITE.

This is also a most singular position. Every one of Black's pieces has been withdrawn home, but all of them, although apparently awkwardly placed like the Queen and Knight, take part in the attack, and are ready to act, while, on the other hand, White, who seems to have the better development, is rather helpless, the White Queen being unable to move. A speedy termination in favour of Black seems somewhat surprising.

Black proceeded as follows:—

	1. B to Q2

(threatening B to K sq).

2P to Kt5	2. R to B2

A subtle move. If P × P, then P to Kt3 wins the Queen, or if P to Kt6, then R to B4 likewise wins the Queen.

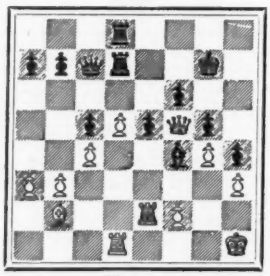
3. K to R2	

In the vain hope of being able to play R to Kt sq, Q to R4 was better.

	3. P × P
4. Kt × P	4. P to K5 (ch)
5. K to R sq	5. B × Kt
6. B × B	6. P to Kt3
7. Q to R4	7. R to R2
8. Q to B4	8. B × P
9. K to Kt sq	9. B to Kt7
Resigns.	

White lost time on his third and fifth move, but Black will maintain a winning attack against best play.

BLACK.



WHITE.

White played.	
1. R to K4	Q to Q3
2. R × B !	KtP × R
3. P to Kt5	K to B2
4. R to KKt sq	K to Q2
5. Q to R7 (ch)	K to K sq
6. Q to R5 (ch)	R to B2
7. P × P	Q × BP
8. R to Kt5 !	K to K2
9. B × P	Q to QKt3
10. R to Kt6	Resigns.

GAME PLAYED IN THE TOURNAMENT OF THE BRITISH CHESS ASSOCIATION.

(CENTRE GAMBIT.)

WHITE. J. Gunsberg.	BLACK. J. Mortimer.	WHITE. J. Gunsberg.	BLACK. J. Mortimer.
1. P to K4	P to K4	13. Kt to Kt5 (*c*)	P to Kt3
2. P to Q4	P × P	14. QKt to K4	P to B4 (*d*)
3. Q × P	QKt to B3	15. P to Kt4	P × Kt (*e*)
4. Q to B4 (*a*)	Kt to B3	16. P × Kt	QP × P
5. Kt to QB3	B to Kt5	17. RP × P	RP × P
6. B to Q2	P to Q3	18. B × B	Kt × B
7. Castles QR	P to QR3	19. Q × KP (*f*)	Kt × P (ch)
8. P to B4	Castles	20. K to Kt sq	B to B4 ?
9. Kt to B3	B to Q2	21. R × Q	B × Q
10. P to KR3	P to QKt4	22. R × R (ch)	R × R
11. Q to K2	R to K sq	23. Kt × B	Kt to Kt5
12. P to K5	Kt to KR4(*b*)	24. Kt to B6 (ch)	and wins.

NOTES.

(*a*) Having played the Queen, it is not very material where she goes to. On B4 the Q escapes attack more readily than on K3—at least for the present.

(*b*) A tempting move, but, as will be seen, it leads Black into complications.

(*c*) Preventing Black from playing Kt to Kt6, as then White would reply with Q to Q3, threatening mate.

(*d*) P to Q4 would have been better.

(*e*) Kt × BP should have been played.

(*f*) The game cannot be saved now. Q to K2 is useless.

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